WQCC-APPROVED

TOTAL MAXIMUM DAILY LOAD (TMDL)
FOR THE
WATERS OF THE VALLE VIDAL

SEPTEMBER 30, 2011

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COVER PHOTO: *LaBelle Creek, October 2006.*

LIST OF ABBREVIATIONS

4Q3	4-Day, 3-year low-flow frequency
BMP	Best management practices
CFR	Code of Federal Regulations
cfs	Cubic feet per second
CGP	Construction general storm water permit
CWA	Clean Water Act
^{o}C	Degrees Celsius
^{o}F	Degrees Fahrenheit
HUC	Hydrologic unit code
$j/m^2/s$	Joules per square meter per second
km^2	Square kilometers
LA	Load allocation
lbs/day	Pounds per day
mgd	Million gallons per day
mg/L	Milligrams per Liter
mi^2	Square miles
mL	Milliliters
MOS	Margin of safety
MOU	Memorandum of Understanding
MS4	Municipal separate storm sewer system
MSGP	Multi-sector general storm water permit
NM	New Mexico
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint source
QAPP	Quality Assurance Project Plan
RFP	Request for proposal
SEE	Standard Error of the Estimate
SSTEMP	Stream Segment Temperature Model
SWPPP	Storm water pollution prevention plan
SWQB	Surface Water Quality Bureau
TMDL	Total Maximum Daily Load
USEPA	U.S. Environmental Protection Agency
USFS	U.S. Forest Service
USGS	U.S. Geological Survey
WLA	Waste load allocation
WQCC	Water Quality Control Commission
WQS	Water quality standards (NMAC 20.6.4 as amended through August 31, 2007)
WBP	Watershed-based plan
WWTP	Wastewater treatment plant

EXECUTIVE SUMMARY

Section 303(d) of the Federal Clean Water Act requires states to develop Total Maximum Daily Load (TMDL) management plans for water bodies determined to be water quality limited. A TMDL documents the amount of a pollutant a waterbody can assimilate without violating a state's water quality standards. It also allocates that load capacity to known point sources and nonpoint sources at a given flow. TMDLs are defined in 40 Code of Federal Regulations Part 130 as the sum of the individual Waste Load Allocations (WLAs) for point sources and Load Allocations (LAs) for nonpoint source and background conditions. TMDLs also include a Margin of Safety (MOS).

The Surface Water Quality Bureau (SWQB) conducted a water quality survey of the Valle Vidal Basin of north-central New Mexico in 2006. Water quality monitoring stations were located within the watershed to evaluate the impact of tributary streams and ambient water quality conditions as well as to collect baseline data on the Valle Vidal after its nomination as an Outstanding National Resource Water. The waters of the Valle Vidal were nominated as Outstanding National Resource Waters in 2005 by three state agencies with full support from a coalition of 250 local governments, businesses and organizations. The nomination recognized the exceptional recreational and ecological significance of the area, and sought to provide further incentive to maintain water quality into the future for the benefit of humans and wildlife. The Water Quality Control Commission held a public hearing and approved the designation in December 2005. EPA approval followed in June 2006.

As a result of assessing data generated during this monitoring effort, impairment determinations of New Mexico water quality standards include the following:

- PLANT NUTRIENTS in Middle Ponil Creek
- TEMPERATURE in Gold Creek, Holman Creek, LaBelle Creek, and North Ponil Creek

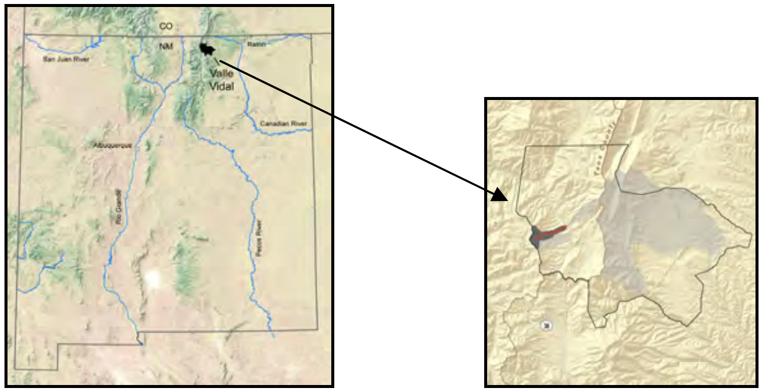
This TMDL document addresses the above noted impairments as summarized in the tables below. The data used to develop this TMDL were collected during the 2006 Valle Vidal survey. The 2006 study identified other potential water quality impairments which are not addressed in this document. Additional data is needed for verification of those impairments and if verified, subsequent TMDLs will be prepared in a separate document. Section 2.0 contains further discussion of listings not addressed in this TMDL.

The SWQB's Monitoring and Assessment Section will collect water quality data during the next rotational cycle. The next scheduled monitoring date for the Valle Vidal Watershed is 2016-2017 at which time TMDL targets will be re-examined and potentially revised as this document is considered to be an evolving management plan. In the event that new data indicate that the targets used in this analysis are not appropriate and/or if new standards are adopted, the load capacity will be adjusted accordingly. When water quality standards have been achieved, the reach will be moved to the appropriate category in the Integrated Report.

The SWQB's Watershed Protection Section will continue work with watershed groups to develop Watershed-Based Plans to implement strategies that attempt to correct the water quality impairments detailed in this document. Implementation of items detailed in the Watershed-Based Plans will be done with participation of all interested and affected parties.

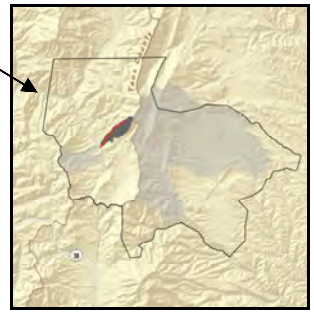
The draft TMDL was made available for a 30-day comment period beginning on June 6, 2011 and ended July 8, 2011. A public meeting was held at the Mora Independent School District Board Room on June 21, 2011. No written public comments were received.

TOTAL MAXIMUM DAILY LOAD FOR
GOLD CREEK (COMANCHE CREEK TO HEADWATERS)



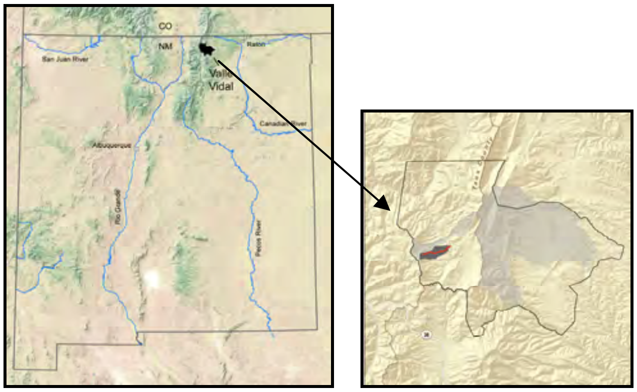
New Mexico Standards Segment	20.6.4.123
Waterbody Identifier	NM-2120.A_835
Segment Length	2.87 miles
Parameters of Concern	Temperature
Uses Affected	High Quality Coldwater Aquatic Life
Geographic Location	Upper Rio Grande USGS Hydrologic Unit Code 13020101
Scope/size of Watershed	2.21 square miles
Land Type	Southern Rockies (Ecoregion 21)
Land Use/Cover	68% forest and 32% rangeland.
Probable Sources	Channelization, drought-related impacts, forest roads (road construction and use), low water crossing, natural sources, rangeland grazing.
Land Management	100% USFS.
IR Category	5/5A
Priority Ranking	High
TMDL for: Temperature	**WLA + LA + MOS = TMDL** **0 + 144.71 + 16.08 = 160.79 j/m^2/s/day**

TOTAL MAXIMUM DAILY LOAD FOR
HOLMAN CREEK (COMANCHE CREEK TO HEADWATERS)



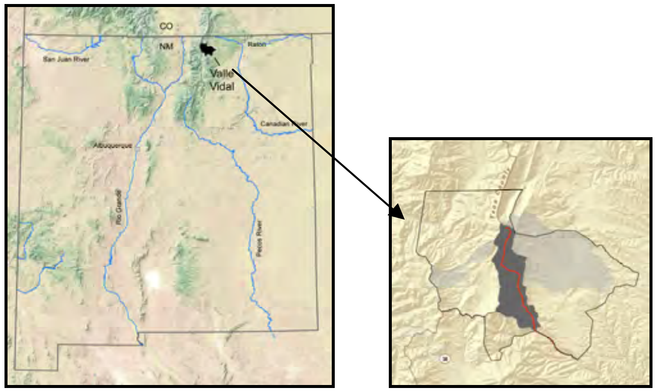
New Mexico Standards Segment	20.6.4.123
Waterbody Identifier	NM-2120.A_837
Segment Length	2.86 miles
Parameters of Concern	Temperature
Uses Affected	High Quality Coldwater Aquatic Life
Geographic Location	Upper Rio Grande USGS Hydrologic Unit Code 13020101
Scope/size of Watershed	1.89 square miles
Land Type	Southern Rockies (Ecoregion 21)
Land Use/Cover	59% forest and 41% rangeland.
Probable Sources	Channelization, drought-related impacts, forest roads (road construction and use), low water crossing, rangeland grazing, wildlife other than waterfowl.
Land Management	100% USFS.
IR Category	5/5A
Priority Ranking	High
TMDL for: Temperature	**WLA + LA + MOS = TMDL** **0 + 124.04 + 13.78 = 137.82 j/m²/s/day**

TOTAL MAXIMUM DAILY LOAD FOR
LABELLE CREEK (COMANCHE CREEK TO HEADWATERS)



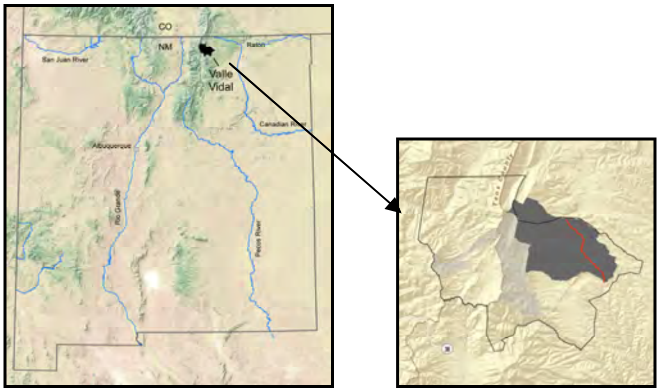
New Mexico Standards Segment	20.6.4.123
Waterbody Identifier	NM-2120.A_839
Segment Length	2.57 miles
Parameters of Concern	Temperature
Uses Affected	High Quality Coldwater Aquatic Life
Geographic Location	Upper Rio Grande USGS Hydrologic Unit Code 13020101
Scope/size of Watershed	1.73square miles
Land Type	Southern Rockies (Ecoregion 21)
Land Use/Cover	42% forest and 58% rangeland.
Probable Sources	Channelization, drought-related impacts, forest roads (road construction and use), low water crossing, rangeland grazing, wildlife other than waterfowl.
Land Management	100% USFS.
IR Category	5/5A
Priority Ranking	High
TMDL for: Temperature	**WLA + LA + MOS = TMDL** **0 + 139.59 + 15.51 = 155.10 j/m^2/s/day**

TOTAL MAXIMUM DAILY LOAD FOR
MIDDLE PONIL CREEK (GREENWOOD CREEK TO HEADWATERS)



New Mexico Standards Segment	20.6.4.309
Waterbody Identifier	NM-2306.A_124
Segment Length	11 miles
Parameters of Concern	Nutrients
Uses Affected	High Quality Coldwater Aquatic Life
Geographic Location	Cimarron USGS Hydrologic Unit Code 11080002
Scope/size of Watershed	18.43 square miles
Land Type	Southern Rockies (Ecoregion 21)
Land Use/Cover	78% forest and 22% rangeland.
Probable Sources	On-site Treatment Systems (Septic Systems and Similar Decentralized Systems), Rangeland Grazing, Source Unknown, Wildlife Other than Waterfowl, wildfire impacts.
Land Management	99% USFS and <1% private.
IR Category	5/5A
Priority Ranking	High
TMDL for: Nutrients- Total Phosphorus Total Nitrogen	**WLA + LA + MOS = TMDL** **0 + 0.10 + 0.01 = 0.11 lbs/day** **0 + 1.18 + 0.13 = 1.31 lbs/day**

TOTAL MAXIMUM DAILY LOAD FOR
NORTH PONIL CREEK (SEALLY CANYON TO HEADWATERS)



New Mexico Standards Segment	20.6.4.309
Waterbody Identifier	NM-2306.A_162
Segment Length	7.03 miles
Parameters of Concern	Temperature
Uses Affected	High Quality Coldwater Aquatic Life
Geographic Location	Cimarron USGS Hydrologic Unit Code 11080002
Scope/size of Watershed	36.84 square miles
Land Type	Southern Rockies (Ecoregion 21)
Land Use/Cover	64% forest and 36% rangeland.
Probable Sources	Habitat modification (other than hydromodification), natural sources, rangeland grazing, source unknown, wildlife other than waterfowl, wildfire impacts, forest roads (road construction and use), low water crossing, drought-related impacts.
Land Management	87% USFS and 13% private.
IR Category	5/5C
Priority Ranking	High
TMDL for: Temperature	**WLA + LA + MOS = TMDL** **0 + 115.17 + 12.80 = 127.97 j/m^2/s/day**

1.0 INTRODUCTION

Under Section 303 of the federal Clean Water Act (CWA), states establish water quality standards, which are submitted and subject to the approval of the U.S. Environmental Protection Agency (USEPA). Under Section 303(d)(1) of the CWA, states are required to develop a list of waters within a state that are impaired and establish a total maximum daily load (TMDL) for each pollutant. A TMDL is defined as "*a written plan and analysis established to ensure that a waterbody will attain and maintain water quality standard including consideration of existing pollutant loads and reasonably foreseeable increases in pollutant loads*" (USEPA 1999). A TMDL documents the amount of a pollutant a waterbody can assimilate without violating a state's water quality standards. It also allocates that load capacity to known point sources and nonpoint sources at a given flow. TMDLs are defined in 40 Code of Federal Regulations (CFR) Part 130 as the sum of the individual Waste Load Allocations (WLAs) for point sources and Load Allocations (LAs) for nonpoint sources and natural background conditions." TMDLs also include a margin of safety (MOS). This document provides TMDLs for assessment units within the Valle Vidal that have been determined to be impaired based on a comparison of measured concentrations and conditions with numeric water quality criteria or with numeric translators for narrative standards.

This document is divided into several sections. Section 2.0 provides background information on the location and history of the Valle Vidal, provides applicable water quality standards for the assessment units addressed in this document, and briefly discusses the intensive water quality survey that was conducted in the Valle Vidal in 2006. Section 3.0 provides a plant nutrient TMDL and Section 4.0 contains temperature TMDLs. Pursuant to CWA Section 106(e)(1), Section 5.0 provides a monitoring plan in which methods, systems, and procedures for data collection and analysis are discussed. Section 6.0 discusses implementation of TMDLs and the relationship between TMDLs and Watershed-Based Plans (WBPs). Section 7.0 discusses assurance, Section 8.0 public participation in the TMDL process, and Section 9.0 provides references.

2.0 VALLE VIDAL CHARACTERISTICS

The Valle Vidal was sampled by the Surface Water Quality Bureau (SWQB) from April to November 2006 (NMED/SWQB, 2011). Water quality monitoring stations were located within the management unit to evaluate the impact of tributary streams and ambient water quality conditions as well as to collect baseline data on the Valle Vidal after its nomination as an Outstanding National Resource Water in 2005. Information regarding sampling efforts by SWQB in the Valle Vidal watershed is detailed in the Water Quality Survey Summary for the Valle Vidal Watershed (NMED/SWQB, 2011) available on the SWQB website. A number of water quality impairments identified during this survey are addressed in this document.

The waters of the Valle Vidal were nominated as Outstanding National Resource Waters in 2005 by three state agencies with full support from a coalition of 250 local governments, businesses and organizations. The nomination recognized the exceptional recreational and ecological significance of the area, and sought to provide further incentive to maintain water quality into the future for the benefit of humans and wildlife. The Water Quality Control Commission held a public hearing and approved the designation in December 2005. EPA approval followed in June 2006. http://www.nmcpr.state.nm.us/nmregister/xvii/xvii02/20.6.4amend.pdf

Gross alpha and radium exceedences were noted on North Ponil Creek, but there are no industrial sources in the region. Therefore, the gross alpha exceedences were attributed to natural sources. Although radiological contaminants have numerous origins such as atomic energy, medical diagnosis and treatment, and mining of radioactive materials, certain locations have elevated levels of naturally occurring radioactivity. Radium is present in all uranium minerals and is common in virtually all rock, soil, and water. Usually concentrations are very low; however, geologic processes can form concentrations of naturally radioactive elements, especially uranium and radium. Large uranium deposits are known to be in Ontario, New Mexico, Utah, and Australia (http://periodic.lanl.gov/elements/88.html). Both gross alpha and radium enter the environment through erosion of natural deposits of certain minerals that are radioactive.

2.1 Location Description

The Valle Vidal (US Geological Survey [USGS] Hydrologic Unit Codes [HUC] 11080002 and 13020101) is located in north-central New Mexico (NM) in Colfax and Taos counties. The Valle Vidal was donated to the American people in 1982 and is now administered as a special unit by the Questa District of the Carson National Forest. The entire Valle Vidal Management Unit of the Carson National Forest is 100,000 acres. The waters within the Valle Vidal were nominated as Outstanding National Resource Waters because of their remarkable fish, wildlife, scenery as well as historic and recreational values. The entire Rio Costilla drainage, which includes Comanche Creek and its tributaries, is eligible to be classified as “wild, scenic or recreational” under the Wild and Scenic Rivers Act.

The Valle Vidal watershed is located in Omernik Level III Ecoregion 21 (Southern Rockies). As presented in **Figure 2.1**, land cover includes forest, shrubland, and grassland. Most of the land ownership adjacent to the waters is US Forest Service (USFS) with the exceptions of a few private parcels (**Figure 2.2**).

Numerous species within this watershed are listed as either threatened or endangered by both State and Federal agencies. Federally listed endangered and threatened species of particular interest due to reliance on aquatic and riparian habitat in the watershed include the suckermouth minnow, Rio Grande cutthroat trout, bald eagle, piping plover, Mexican spotted owl, American marten, Lillijeborg peaclam, Sangre de Cristo peaclam, Rio Grande silvery minnow, American peregrine falcon, white-tailed ptarmigan, Boreal owl, Southwestern Willow Flycatcher, and New Mexican jumping mouse (http://nhnm.unm.edu/query_bcd/bcd_watershed_query.php5).

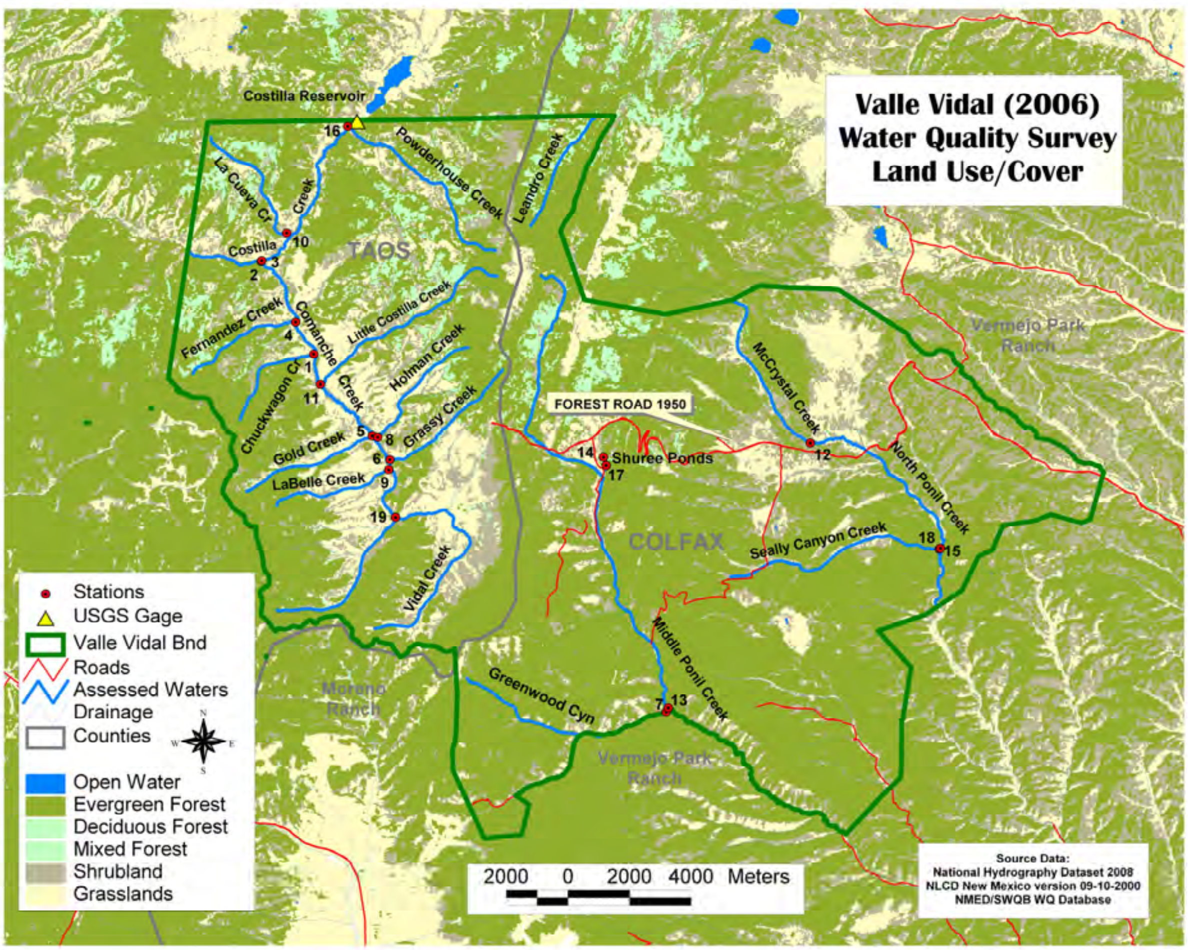


Figure 2.1 Land Cover and 2006 Sampling Stations in the Valle Vidal Watershed. See Table 2.1 for station information.

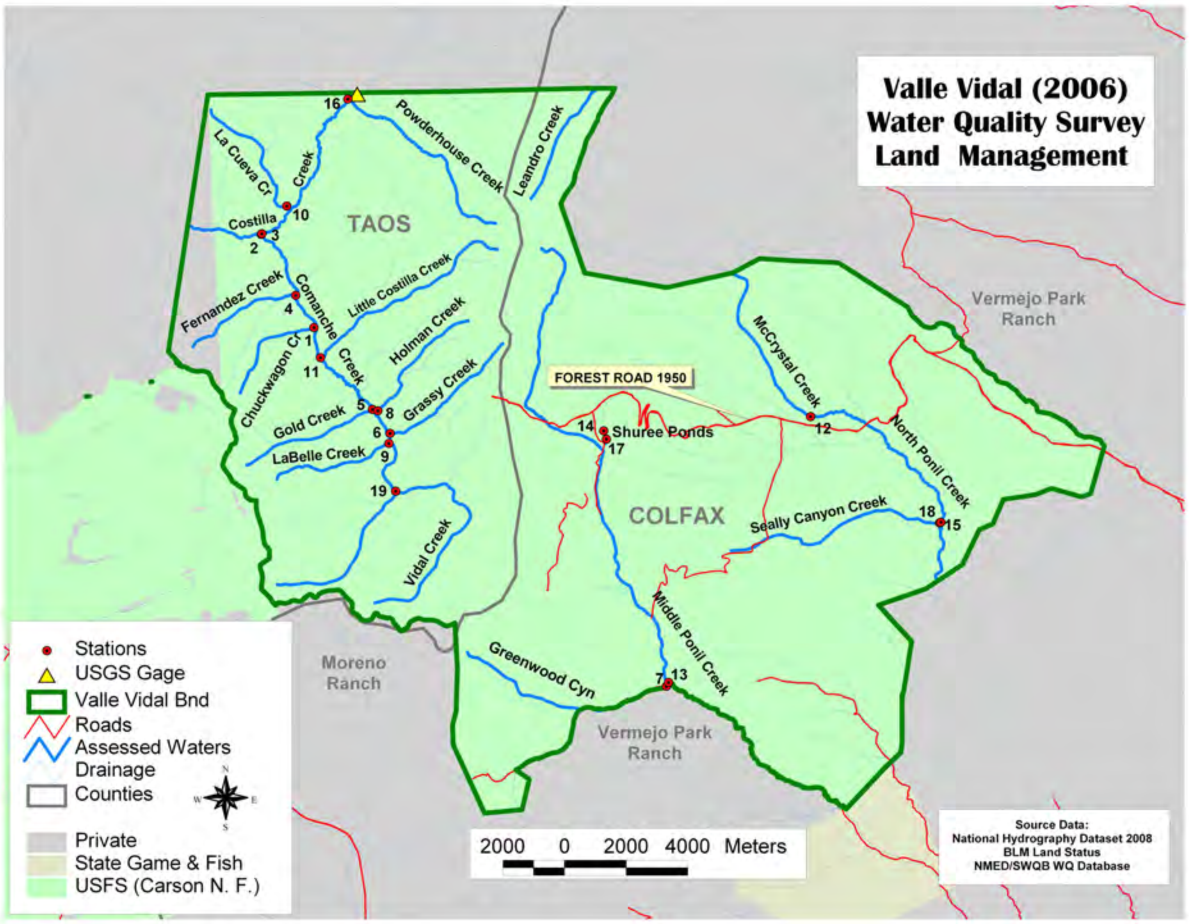


Figure 2.2 Land Management and 2006 Sampling Stations in the Valle Vidal Watershed

2.2 Geology and Land Use

Nineteen waters within the Valle Vidal Management Area were sampled during the 2006 survey. Historic and current land uses in these watersheds include farming, ranching, and recreation. Most of the land ownership is United States Forest Service (USFS with a few private tracts). These waters are located in Omernick Level III ecoregion 21 (Southern Rockies). The elevation range for the various watersheds in the survey spanned from 2,390 to 3,826 meters (7,840 to 12,554 feet above sea level).

The Folsom people inhabited the area 10,000 years ago and by the 1500's, the area was settled by the Jicarilla Apache. The area was then given to settlers as part of the Beaubien-Miranda Land Grant which was later known as the Maxwell Grant. Maxwell sold the grant and it was eventually bought by Bartlett, who created Vermejo Park and from 1926 to 1973, the area served as a sportsman's ranch for the wealthy. The land was sold to Penzoil Company in 1973. After years of oil exploration, Penzoil Company gave the land to the American people via the US Forest Service (Coalition for the Valle Vidal, http://www.vallevidal.org/). The 100,000 acres of the Valle Vidal Wildlife Management Unit are now managed by the Quest District of the Carson National Forest.

The predominant lithologies within the Valle Vidal are sandstones to the east and volcanic, metamorphic, and alluvium to the west. (**Figure 2.3**). The Valle Vidal is on the western edge of the Raton Basin, which marks the transition from the Sangre de Cristo Mountains to the Great Plains region. Both coal and gold were historically mined in the area (Chronic, 1987). The Pierre Formation, a Cretaceous shale, forms many local slopes and pediments. Distinct Oligocene igneous dikes cut across the basin, forming the Rock Wall that separates the east from the west side of the Valle Vidal (http://www.ouachitamaps.com/Valle%20Vidal.html). The western side is predominately the Poison Canyon Formation and Piedmont alluvial deposits. The eastern side is a mix of lower Miocene and Upper Oligocene volcanic rocks, Lower Proterozoic metamorphic rocks, Upper Oligocene andesites, and the Lower and Middle Santa Fe Group.

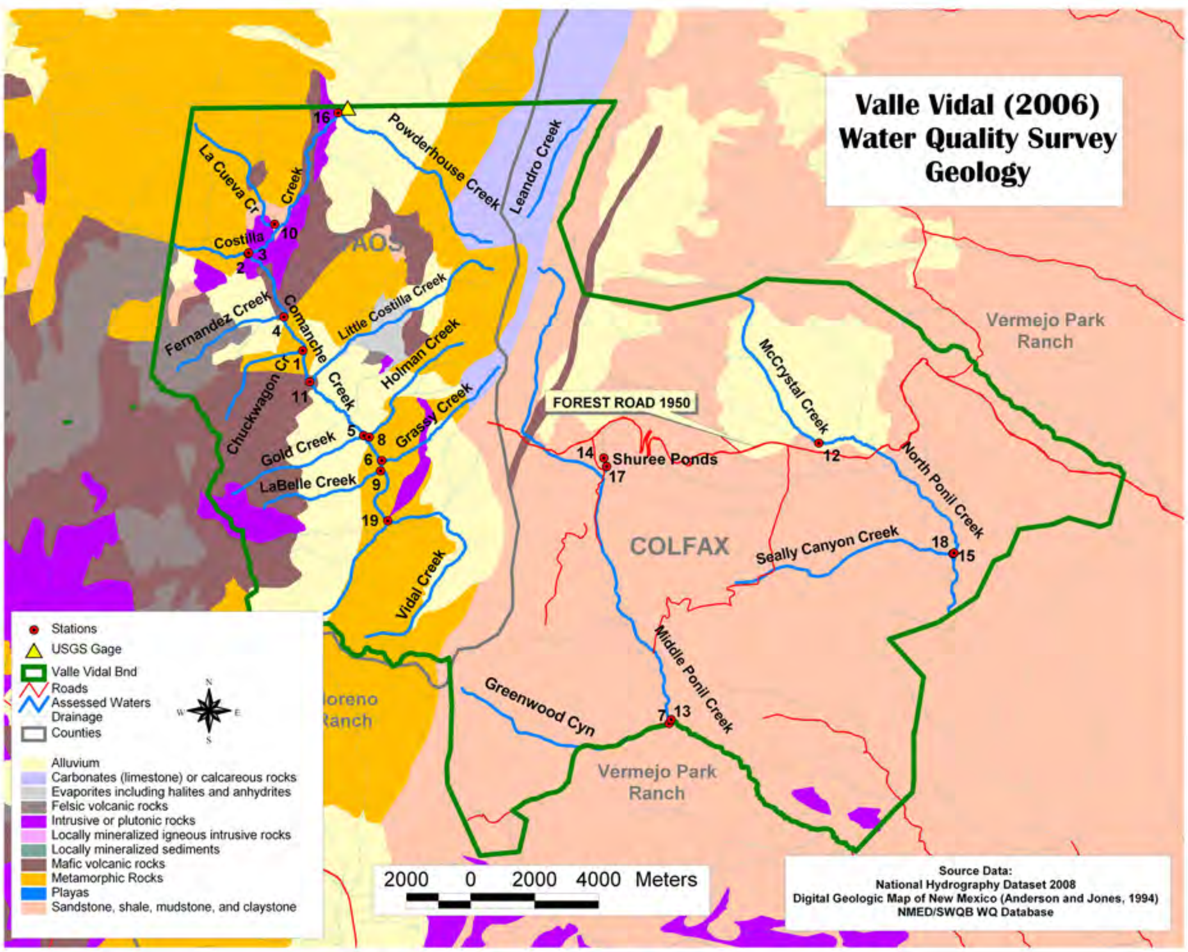


Figure 2.3 Geologic Map of the Valle Vidal Watershed and 2006 Sampling Stations

2.3 Water Quality Standards and Designated Uses

Water quality standards (WQS) for all assessment units in this document are set forth in sections, 206.4.123 and 20.6.4.309 of the *Standards for Interstate and Intrastate Surface Water s,* 20.6.4 New Mexico Administrative Code (NMAC 2011). These standards have been approved by EPA for Clean Water Act purposes.

20.6.4.123 RIO GRANDE BASIN - Perennial reaches of the Red river upstream of the mouth of Placer creek, all perennial reaches of tributaries to the Red river, and all other perennial reaches of tributaries to the Rio Grande in Taos and Rio Arriba counties unless included in other segments and excluding waters on Santa Clara, Ohkay Owingeh, Picuris and Taos pueblos.

A. Designated Uses: domestic water supply, high quality coldwater aquatic life, irrigation, livestock watering, wildlife habitat and primary contact; and public water supply on the Rio Pueblo and Rio Fernando de Taos.

B. Criteria: the use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses, except that the following segment-specific criteria apply: specific conductance 400 µS/cm or less (500 µS/cm or less for the Rio Fernando de Taos); the monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less, single sample 235 cfu/100 mL or less; and phosphorus (unfiltered sample) less than 0.1 mg/L for the Red river.

[20.6.4.123 NMAC - Rp 20 NMAC 6.1.2120, 10-12-00; A, 05-23-05; A, 12-01-10] [**NOTE:** The segment covered by this section was divided effective 05-23-05. The standards for the additional segment are under 20.6.4.129 NMAC.]

20.6.4.309 CANADIAN RIVER BASIN - The Mora river and perennial reaches of its tributaries upstream from the state highway 434 bridge in Mora, all perennial reaches of tributaries to the Mora river upstream from the USGS gaging station at La Cueva, perennial reaches of Coyote creek and its tributaries, the Cimarron river and its perennial tributaries above state highway 21 in Cimarron, all perennial reaches of tributaries to the Cimarron river north and northwest of highway 64, perennial reaches of Rayado creek and its tributaries above Miami lake diversion, Ocate creek and perennial reaches of its tributaries upstream of Ocate, perennial reaches of the Vermejo river upstream from Rail canyon and all other perennial reaches of tributaries to the Canadian river northwest and north of U.S. highway 64 in Colfax county unless included in other segments.

A. Designated Uses: domestic water supply, irrigation, high quality coldwater aquatic life, livestock watering, wildlife habitat, and primary contact; and public water supply on the Cimarron River upstream from Cimarron, on Eagle Nest lake and on perennial reaches of Rayado creek and its tributaries.

B. Criteria: the use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses, except that the following segment-specific criteria apply: specific conductance 500 µS/cm or less; the monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less, single sample 235 cfu/100 mL or less.

[20.6.4.309 NMAC - Rp 20 NMAC 6.1.2306, 10-12-00; A, 7-19-01; A, 05-23-05; A, 12-01-10] [**NOTE:** The segment covered by this section was divided effective 05-23-05. The standards for the additional segment are under 20.6.4.310 NMAC.]

The numeric criteria identified in these sections are used for assessing waters for use attainability. The referenced Section 20.6.4.900 NMAC provides a list of water chemistry analytes for which SWQB tests and identifies numeric criteria for specific designated uses. In addition, waters are assessed against the narrative criteria identified in Section 20.6.4.13 NMAC, including bottom sediments and suspended or settleable solids, plant nutrients, and turbidity. The individual water quality criteria or narrative standards are detailed for each parameter in the chapters that follow. The WQS approved in 2011 include changes to temperature criteria; the details of these changes that are applicable to some of the assessment units are discussed in Section 4.0.

Current impairment listings for the Valle Vidal Watershed are included in the 2010-2012 State of New Mexico Clean Water Act §303(d)/ §305(b) Integrated List (NMED/SWQB 2010b). The Integrated List is a catalog of assessment units (AUs) throughout the state with a summary of their current status as assessed/not assessed or impaired/not impaired. AU names and WQS have changed over the years and the history of these individual changes is tracked in the Record of Decision document associated with the 2010-2012 Integrated List available on the SWQB website.

New Mexico's antidegradation policy is articulated in Subsection A of 20.6.4.8 NMAC. It mandates that "the level of water quality necessary to protect the existing uses shall be maintained and protected in all surface waters of the state." TMDLs are consistent with this policy because implementation of a TMDL restores water quality so that existing uses are protected and water quality criteria achieved.

2.4 Water Quality Sampling

The Valle Vidal was sampled by the SWQB in 2006. A brief summary of the survey and the hydrologic conditions during the sample period is provided in the following subsections. A more detailed description can be found in Valle Vidal Water Quality Survey Summary (NMED/SWQB 2011).

2.4.1 Survey Design

The Monitoring and Assessment Section (MAS) of the SWQB conducted a water quality survey of the Valle Vidal watershed in 2006 between April and November. This water quality survey included 21 sampling sites (**Figure 2.1 and Table 2.1**). Most sites were sampled at least 4 times. Monitoring these sites enabled an assessment of the cumulative influence of the physical habitat, water sources, and land management activities upstream from the sites. Data results from grab sampling are housed in the SWQB provisional water quality database and were uploaded to USEPA's Storage and Retrieval (STORET) database.

All temperature and chemical/physical sampling and assessment techniques are detailed in the *Quality Assurance Project Plan* (NMED/SWQB 2006) and the SWQB assessment protocols (NMED/SWQB 2007). As a result of the 2006 monitoring effort and subsequent assessment of results, several surface water impairments were determined. Accordingly, these impairments were added to New Mexico's Integrated CWA §303(d)/305(b) List in 2008 (NMED/SWQB 2010b).

Table 2.1 SWQB 2006 Valle Vidal Basin Sampling Stations

Station #	Station Description	STORET/ WQX ID
1	Chuckwagon Cr abv Comanche Cr	28Chuckw000.1
2	Comanche Creek above Costilla Creek	28Comanc000.1
3	Costilla Cr abv Comanche Cr	28RCosti032.5
4	Fernandez Cr abv Comanche Cr	28Fernan000.1
5	Gold Cr abv Comanche Cr	28GoldCr000.1
6	Grassy Creek above Comanche Creek	28Grassy000.1
7	Greenwood Creek above Middle Ponil Creek	05Greenw000.1
8	Holman Cr abv Comanche Cr	28Holman000.1
9	La Belle Cr abv Comanche Cr	28LaBell000.1
10	La Cueva Cr abv Costilla Cr	28LaCuev000.2
11	Little Costilla Cr abv Comanche Cr	28LCosti000.1
12	McCrystal Cr at USFS Campground	05McCrys002.0
13	Middle Ponil Creek above Greenwood Creek	05MPonil016.2
14	N. Shuree Pond Deep	05NShureeDeep
15	North Ponil Cr abv Seally Cr	05NPonil023.2
16	Powderhouse Cr abv Costilla Cr	28Powder000.1
17	S. Shuree Pond Deep	05SShureeDeep
18	Seally Cr abv N Ponil Cr	05Seally000.2
19	Vidal Creek above Comanche Creek	28VidalC000.1

2.4.2 Hydrologic Conditions

There is one active USGS gaging stations in the Valle Vidal watershed, Costilla Creek below Costilla Dam (USGS 08254000). The mean daily discharge for this gage was 40.8 cfs in 2006 (April-October). **Figure 2.4** displays the mean discharge for 2007 and **Figure 2.5** displays the mean discharge for the period of record.

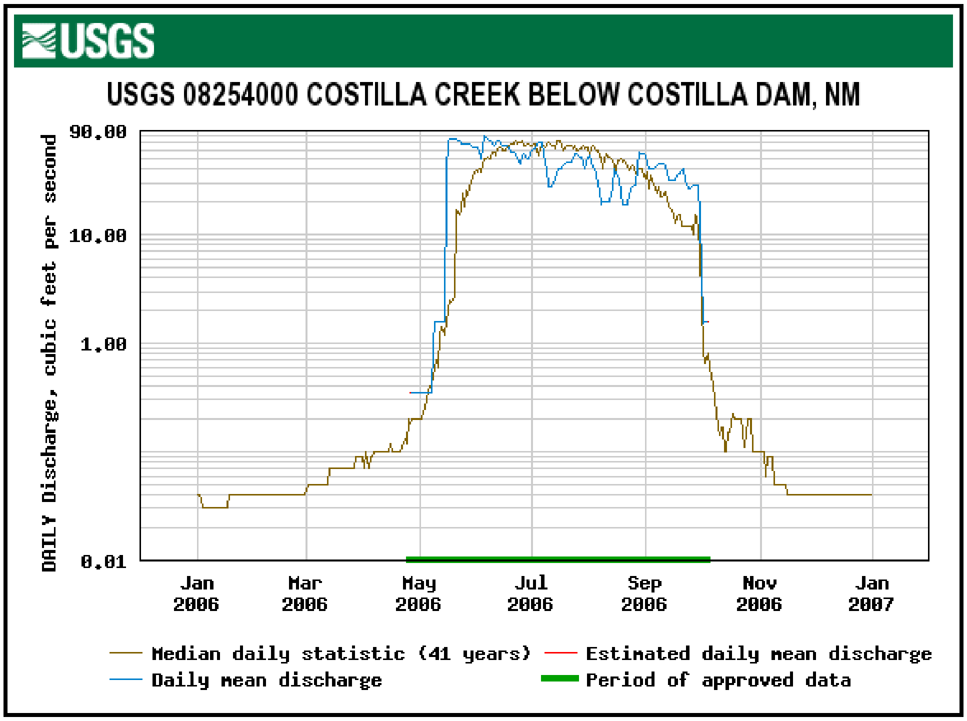


Figure 2.4 Daily mean discharge for Costilla Creek below Costilla Dam, NM (2006)

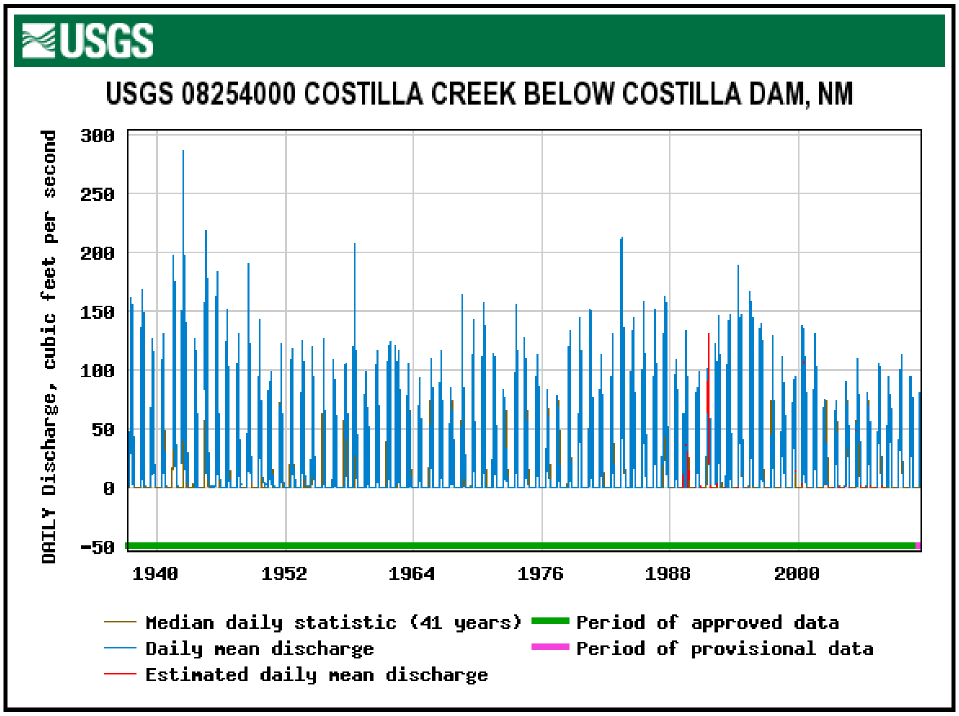


Figure 2.5 Daily mean discharge for Costilla Creek below Costilla Dam, NM (1937-2011)

As described in the following sections, 4Q3 low-flow was estimated using Waltemeyer's (2002) analysis. The 4Q3 calculations for the five Assessment Units discussed in this document are as follows-

Gold Creek (Comanche Creek to headwaters)	-	0.14 cfs
Holman Creek (Comanche Creek to headwaters)	-	0.15 cfs
LaBelle Creek (Comanche Creek to headwaters)	-	0.07 cfs
Middle Ponil Creek (Greenwood Creek to headwaters)	-	0.99 cfs
North Ponil Creek (Seally Canyon to headwaters)	-	0.20 cfs

Discharge measurements were measured during a number of the site visits during 2006. The field measurements for the five Assessment Units discussed in this document are displayed in Table 2.2.

Table 2.2 2006 Discharge Field Measurements for TMDL Sites

Site	2006 discharge measurements (cfs)			
	April 13/21	May 23/24	Aug 10/11	Oct 5/6
28GoldCr000.1	1.17	n/a	0.08	0.069
28Holman000.1	0.24 [a]	n/a	0.04	0.004
28LaBell000.1	0.85	0.03	0.06	0.06
05MPonil016.2	3.682	0.97	1.68	0.94
05NPonil023.2	12.26	n/a	4.75	n/a

n/a = not applicable
[a] Discharge was measured on both dates in 2006; April 13 and 21.

As stated in the Assessment Protocol (NMED/SWQB 2009), data collected during all flow conditions, including low flow conditions (i.e., flows below 4-day, 3-year flows [4Q3]), will be used to determine designated use attainment status during the assessment process. For the purpose of assessing designated use attainment in ambient surface waters, WQS apply at all times under all flow conditions.

3.0 PLANT NUTRIENTS

The potential for excessive nutrients in Comanche Creek (Costilla Creek to headwaters), Costilla Creek (Comanche Creek to Costilla Dam), Middle Ponil Creek (Greenwood Creek to headwaters), and North Ponil Creek (Seally Canyon to headwaters) were noted through visual observation (Level 1 Nutrient Survey) during the 2006 watershed survey. Further assessment of various water quality parameters (Level 2 Nutrient Survey) indicated nutrient impairment in Middle Ponil Creek (Greenwood Creek to headwaters).

3.1 Target Loading Capacity

For this TMDL document the target value for plant nutrients is based on numeric translators for the narrative criterion set forth in Subsection E of 20.6.4.13 NMAC:

> ***Plant Nutrients:*** *Plant nutrients from other than natural causes shall not be present in concentrations which will produce undesirable aquatic life or result in the dominance of nuisance species in surface waters of the state.*

There are two potential contributors to nutrient enrichment in a given stream: excessive nitrogen and/or phosphorus. The reason for controlling plant growth is to preserve aesthetic and ecologic characteristics along the waterway. The intent of criteria for phosphorus and nitrogen is to control the excessive growth of attached algae and higher aquatic plants that can result from the introduction of these plant nutrients into streams. Numeric criteria or translators are necessary to establish targets for TMDLs, to develop water quality-based permit limits and source control plans, and to support designated uses within the watershed.

Phosphorous is found in water primarily as ortho-phosphate. In contrast nitrogen may be found as several dissolved species all of which must be considered in loading. Total Nitrogen is defined as the sum of Nitrate+Nitrite (N+N), and Total Kjeldahl Nitrogen (TKN). At the present time, there is no EPA-approved method to test for Total Nitrogen, however a combination of EPA method 351.2 (TKN) and EPA method 353.2 (Nitrate + Nitrite) is appropriate for estimating Total Nitrogen.

Development of numeric translators for the plant nutrients criterion is the result of a three-step analysis. First, the EPA compiled nutrient data from the national nutrient dataset, divided it by waterbody type, grouped it into nutrient ecoregions, and calculated the 25th percentiles for each Level III ecoregion. EPA published these recommended water quality criteria to help states and tribes reduce problems associated with excess nutrients in waterbodies in specific areas of the country (USEPA 2000). Next a U.S. Geological Survey (USGS) employee, Evan Hornig, who assisted EPA Region 6 with nutrient criteria development, refined the recommended ecoregional nutrient criteria. Hornig used regional nutrient data from EPA's Storage and Retrieval System (STORET), the USGS, and the SWQB to create a regional dataset for New Mexico. Threshold values were calculated based on EPA procedures and the median for each Level III ecoregion.

The third round of analysis was conducted by SWQB to produce nutrient threshold values for streams based on ecoregion and designated aquatic life use. For this analysis, total phosphorus (TP), total Kjeldahl nitrogen (TKN), and nitrate plus nitrite (N+N) data from the National Nutrient Dataset (1990-1997) were combined with Archival STORET data from 1998, and 1999-2006 data from the SWQB in-house database. The data were then divided by waterbody type, removing all rivers, reservoirs, lakes, wastewater treatment effluent, and playas. For all of the stream data, Level III and IV Omernik ecoregions (Omernik 2006) as well as the designated aquatic life use were assigned using GIS coverages and the station's latitude and longitude. Medians were calculated for each ecoregion/aquatic life use group. For comparison purposes, values below the detection limit were estimated in two ways; using the substitution method (one half the detection limit) in Excel and using the nonparametric Kaplan-Meier method in Minitab. The threshold values from the SWQB Stream Nutrient Assessment Protocol are shown in Table 3.1. They were generated with the complete dataset using the substitution method given that the substitution and Kaplan-Meier methods produced similar results.

Table 3.1 SWQB's recommended nutrient targets for Southern Rockies (in mg/L)

	Southern Rockies	
Aquatic Life Use →	CW	T/WW (volcanic)
Total Phosphorus	0.02	0.02 (0.05)
Total Nitrogen	0.25	0.25

<u>NOTES</u>: CW = Coldwater (those water quality (WQ) segments having only CW uses)
T = Transitional (those WQ segments with marginal CW or both CW and WW uses)
WW = Warmwater (those WQ segments having only WW uses

Middle Ponil Creek (Greenwood Creek to headwaters) is located in the Southern Rockies. In addition, Middle Ponil Creek is designated as high quality coldwater aquatic life, therefore it is classified as "coldwater" for assessment purposes (20.6.4.116 NMAC). According to Table 3.1, this stream should have nutrient targets of 0.02 mg/L for total phosphorus and 0.25 mg/L for total nitrogen (Table 3.2).

Table 3.2. In-stream nutrient target concentrations

Assessment Unit	Total Phosphorus	Total Nitrogen
Middle Ponil Creek (Greenwood Creek to headwaters)	0.02 mg/L	0.25 mg/L

3.2 Critical Flow

The presence of plant nutrients in a stream can vary as a function of flow. Higher nutrient concentrations typically occur during low-flow conditions because there is reduced stream capacity to assimilate point source discharges due to less streamflow available for dilution. In other words, as flow decreases, the stream cannot effectively dilute its constituents causing the concentration of plant nutrients to increase.

The critical flow condition for Middle Ponil Creek occurs when the ratio of effluent to stream flow is the greatest and was obtained using a 4Q3 regression model. The 4Q3 is the minimum average four consecutive day flow that occurs with a frequency of at least once every 3 years. Low flow was chosen as the critical flow because of the negative effect low flows have on nutrient concentrations and algal growth.

It is often necessary to calculate a critical flow for a portion of a watershed where there is no active flow gage. For the current TMDL analysis, 4Q3 low-flow was estimated using Waltemeyer's (2002) analysis. Waltemeyer developed two regression equations for estimating 4Q3 based on physiographic regions of NM (i.e., statewide and mountainous regions above 7,500 feet in elevation). The following regression equation for mountainous regions above 7,500 feet in elevation is based on data from 40 gaging stations with non-zero discharge (Waltemeyer 2002):

$$4Q3 = 7.3287 \times 10^{-5}\ DA^{0.70}\ P_w^{\ 3.58}\ S^{1.35} \qquad \text{(Eq. 3-1)}$$

where,

4Q3 = Four-day, three-year low-flow frequency (cfs)
DA = Drainage area (mi^2)
P_w = Average basin mean winter precipitation (inches)
S = Average basin slope (percent).

The average SEE and coefficient of determination are 94 and 66 percent, respectively, for this regression equation (Waltemeyer 2002). The 4Q3 low-flow frequency for Middle Ponil Creek estimated using Equation 3-1 is presented in Table 3.3.

Table 3.3. Calculation of 4Q3 Low-Flow Frequency

Assessment Unit	Average elevation (ft)	Drainage area (mi^2)	Mean winter precipitation (in)	Average basin slope	4Q3 (cfs)
Middle Ponil Creek (Greenwood Creek to headwaters)	9757	18.306	11.55	0.31	0.99

The 4Q3 value for Middle Ponil Creek was converted from cubic feet per second (cfs) to units of million gallons per day (mgd) as follows:

$$0.99\,\frac{ft^3}{\sec}\times 1{,}728\frac{in^3}{ft^3}\times 0.004329\frac{gal}{in^3}\times 86{,}400\,\frac{\sec}{day}\times 10^{-6} = 0.64 mgd$$

It is important to remember that the TMDL itself is a value calculated at a defined critical condition, and is calculated as part of planning process designed to achieve water quality standards. Since flows vary throughout the year in these systems, the actual load at any given time will vary based on the changing flow. Management of the load to improve stream water quality should be a goal to be attained.

3.3 Calculations

This section describes the relationship between the numeric target and the allowable pollutant-level by determining the waterbody's total assimilative capacity, or loading capacity, for the pollutant. The loading capacity is the maximum amount of pollutant loading that a waterbody can receive while meeting its water quality objectives.

As a river flows downstream it has a specific carrying capacity for nutrients. This carrying capacity is defined as the mass of pollutant that can be carried under critical low-flow conditions without violating the target concentration for that constituent. The specific carrying capacity of a receiving water for a given pollutant, may be estimated using Equation 3-2.

Flow (mgd) x Numeric Target (mg/L) x 8.34 = TMDL (pounds per day [lbs/day]) (Eq. 3-2)

The daily target loads for TP and TN are summarized in Table 3.4.

Table 3.4. Daily Target Loads for TP & TN

Assessment Unit	Parameter	4Q3 Flow (mgd)	Numeric Target (mg/L)	Conversion Factor	Target Load (lbs/day)
Middle Ponil Creek (Greenwood Creek to hw)	Total Phosphorus	0.64	0.02	8.34	0.11
	Total Nitrogen	0.64	0.25	8.34	1.33

The measured loads for TP and TN were similarly calculated. In order to achieve comparability between the target and measured loads, the same flow value was used for both calculations. The arithmetic mean of the collected data was substituted for the target in Equation 3-2. The same conversion factor of 8.34 was used. The results are presented in Table 3.5.

Table 3.5. Measured Loads for TP and TN

Assessment Unit	Parameter	4Q3 Flow (mgd)	Arithmetic Mean Conc.* (mg/L)	Conversion Factor	Measured Load (lbs/day)
Middle Ponil Creek (Greenwood Creek to hw)	Total Phosphorus	0.64	0.029	8.34	0.15
	Total Nitrogen	0.64	0.40	8.34	2.14

Notes:
* *Arithmetic mean of TP and TN concentrations from SWQB's water quality survey.*

3.4 Waste Load Allocations and Load Allocations

3.4.1 Waste Load Allocation

There are no active point source dischargers on Middle Ponil Creek (Greenwood Creek to headwaters). There are also no Municipal Separate Storm Sewer System (MS4) storm water permits in this AU. However, excess nutrient loading may be a component of some storm water discharges covered under general NPDES permits, so the load from these dischargers should be addressed.

Storm water discharges from construction activities are transient because they occur mainly during the construction itself, and then only during storm events. Coverage under the National Pollutant Discharge Elimination System (NPDES) Construction General Permit (CGP) for construction sites greater than one acre requires preparation of a Storm Water Pollution Prevention Plan (SWPPP) that includes identification and control of all pollutants associated with the construction activities to minimize impacts to water quality. The current CGP also includes state-specific requirements to implement site-specific interim and permanent stabilization, managerial, and structural solids, erosion, and sediment control Best Management Practices (BMPs) and/or other controls. BMPs are designed to prevent to the maximum extent practicable an increase in sediment load to the water body or an increase in a sediment-related parameter, such as total suspended solids, turbidity, siltation, stream bottom deposits, etc. BMPs also include measures to reduce flow velocity during and after construction compared to pre-construction conditions to assure that waste load allocations (WLAs) or applicable water quality standards, including the antidegradation policy, are met. Compliance with a SWPPP that meets the requirements of the CGP is generally assumed to be consistent with this TMDL.

Storm water discharges from active industrial facilities are generally covered under the current NPDES Multi-Sector General Permit (MSGP). This permit also requires preparation of a SWPPP, which includes specific requirements to limit (or eliminate) pollutant loading associated with the industrial activities in order to minimize impacts to water quality. Compliance with a SWPPP that meets the requirements of the MSGP is generally assumed to be consistent with this TMDL.

It is not possible to calculate individual WLAs for facilities covered by these General Permits at this time using available tools. Loads that are in compliance with the General Permits are therefore currently included as part of the load allocation.

3.4.2 Load Allocation

In order to calculate the load allocation (LA) for phosphorus and nitrogen, the WLA and margin of safety (MOS) were subtracted from the target capacity (TMDL) using the following equation:

$$LA = TMDL - MOS - WLA \qquad \text{(Eq. 4-4)}$$

The MOS was developed using a combination of conservative assumptions and explicit recognition of potential errors in flow calculations. Results using an explicit MOS of 10% (see Section 3.7 for details) are presented in Table3.6.

Table 3.6. Calculation of TMDL for TP and TN

Assessment Unit	Parameter	WLA (lbs/day)	LA (lbs/day)	MOS (10%)	TMDL (lbs/day)
Middle Ponil Creek (Greenwood Creek to hw)	Total Phosphorus	0	0.10	0.01	0.11
	Total Nitrogen	0	1.18	0.13	1.31

The load reductions that would be necessary to meet the target loads were calculated to be the difference between the calculated daily target load (Table 3.4) and the measured load (Table 3.5), and are shown in Table 3.7.

Table 3.7. Calculation of Load Reduction for TP and TN

Assessment Unit	Parameter	Target Load (a) (lbs/day)	Measured Load (lbs/day)	Load Reduction (lbs/day)	Percent Reduction (b)
Middle Ponil Creek (Greenwood Creek to hw)	Total Phosphorus	0.10	0.15	0.05	36%
	Total Nitrogen	1.18	2.14	0.96	45%

Notes:
The MOS is not included in the load reduction calculations because it is a set aside value which accounts for any uncertainty or variability in TMDL calculations and therefore should not be subtracted from the measured load.

(a) Target Load = TMDL – MOS (refer to Table 4.6)
(b) Percent reduction is the percent the existing measured load must be reduced to achieve the target load, and is calculated as follows: (Measured Load – Target Load) / Measured Load x 100.

3.5 Identification and Description of Pollutant Sources

SWQB fieldwork includes an assessment of the probable sources of impairment (Appendix B). The approach for identifying "Probable Sources of Impairment" was recently modified by SWQB to include additional input from a variety of stakeholders including landowners, watershed groups, and local, state, tribal and federal agencies. Probable Source Sheets are filled out by SWQB staff during watershed surveys and watershed restoration activities. The draft probable source list will be reviewed and modified, as necessary, with watershed group/ stakeholder input during the TMDL public meeting and comment period.

The Probable Source Identification Sheets in Appendix B provide an approach for a visual analysis of a pollutant source along an impaired reach. Although this procedure is subjective, SWQB feels that it provides the best available information for the identification of probable sources of impairment in a watershed. The list of "Probable Sources" is not intended to single out any particular land owner or single land management activity and has therefore been labeled "Probable" and generally includes several sources for each impairment. Table 3.8 and Table 3.9 display probable sources of impairment along each reach as determined by field reconnaissance and assessment. Probable sources of nutrients will be evaluated, refined, and changed as necessary through the development of a Watershed-Based Plan (WBP).

Table 3.8. Pollutant Source Summary for Total Phosphorus

Assessment Unit	Pollutant Sources	Magnitude (lbs/day)	Probable Sources* (% from each)
Middle Ponil Creek (Greenwood Creek to hw)	Point:	n/a	0%
	Nonpoint:		100% On-site Treatment Systems (Septic Systems and Similar Decentralized Systems); Rangeland Grazing; Wildlife Other than Waterfowl; Source Unknown, wildfire impacts.

Table 3.9. Pollutant Source Summary for Total Nitrogen

Assessment Unit	Pollutant Sources	Magnitude (lbs/day)	Probable Sources* (% from each)
Middle Ponil Creek (Greenwood Creek to hw)	Point:	n/a	0%
	Nonpoint:		100% On-site Treatment Systems (Septic Systems and Similar Decentralized Systems); Rangeland Grazing; Wildlife Other than Waterfowl; Source Unknown, wildfire impacts.

Notes:

* From the 2010-2012 State of New Mexico CWA §303(d)/§305(b) Integrated List (NMED/SWQB 2010b) and staff input. This list of probable sources is based on staff observation, known land use activities in the watershed, and is related to this particular impairment listing. These sources are not confirmed nor quantified at this time.

3.6 Linkage between Water Quality and Pollutant Sources

The source assessment phase of TMDL development identifies sources of nutrients that may contribute to both elevated nutrient concentrations and the stimulation of algal growth in a waterbody. Where data gaps exist or the level of uncertainty in the characterization of sources is large, the recommended approach to TMDL assignments requires the development of allocations based on estimates utilizing the best available information.

Phosphorus and nitrogen generally drive the productivity of algae and macrophytes in aquatic ecosystems, therefore they are regarded as the primary limiting nutrients in freshwaters. The main reservoirs of natural phosphorus are rocks and natural phosphate deposits. Weathering, leaching, and erosion are all processes that breakdown rock and mineral deposits allowing phosphorus to be transported to aquatic systems via water or wind. The breakdown of mineral phosphorus produces inorganic phosphate ions ($H_2PO_4^-$, HPO_4^{2-}, and PO_4^{3-}) that can be absorbed by plants from soil or water (USEPA 1999). Phosphorus primarily moves through the food web as organic phosphorus (after it has been incorporated into plant or algal tissue) where it may be released as phosphate in urine or other waste by heterotrophic consumers and reabsorbed by plants or algae to start another cycle (Nebel and Wright 2000).

The largest reservoir of nitrogen is the atmosphere. About 80 percent of the atmosphere by volume consists of nitrogen gas (N_2). Although nitrogen is plentiful in the environment, it is not readily available for biological uptake. Nitrogen gas must be converted to other forms, such as ammonia (NH_3 and NH_4^+), nitrate (NO_3^-), or nitrite (NO_2^-) before plants and animals can use it. Conversion of gaseous nitrogen into usable mineral forms occurs through three biologically mediated processes of the nitrogen cycle: nitrogen fixation, nitrification, and ammonification (USEPA 1999). Mineral forms of nitrogen can be taken up by plants and algae and incorporated into plant or algal tissue. Nitrogen follows the same pattern of food web incorporation as phosphorus and is released in waste primarily as ammonium compounds. The ammonium compounds are usually converted to nitrates by nitrifying bacteria, making it available again for uptake, starting the cycle anew (Nebel and Wright 2000).

Rain, overland runoff, groundwater, drainage networks, and industrial and residential waste effluents transport nutrients to receiving waterbodies. Once nutrients have been transported into a waterbody they can be taken up by algae, macrophytes, and microorganisms either in the water column or in the benthos; they can sorb to organic or inorganic particles in the water column and/or sediment; they can accumulate or be recycled in the sediment; or they can be transformed and released as a gas from the waterbody (Figure 3.1).

As noted above, phosphorus and nitrogen are essential for proper functioning of ecosystems. However, excess nutrients cause conditions unfavorable for the proper functioning of aquatic ecosystems. Nuisance levels of algae and other aquatic vegetation (macrophytes) can develop rapidly in response to nutrient enrichment when other factors (e.g., light, temperature, substrate, etc.) are not limiting (Figure 3.1). The relationship between nuisance algal growth and nutrient enrichment in stream systems has been well documented in the literature (Welch 1992; Van Nieuwenhuyse and Jones 1996; Dodds et al. 1997; Chetelat et al. 1999). Unfortunately, the magnitude of nutrient concentration that constitutes an “excess” is difficult to determine and varies by ecoregion.

As described in Section 3.2, the presence of plant nutrients in a stream can vary as a function of flow. As flow decreases through water diversions and/or drought-related stressors, the stream cannot effectively dilute its constituents, which causes the concentration of plant nutrients to increase. Nutrients generally reach a waterbody from land uses that are in close proximity to the stream because the hydrological pathways are shorter and have fewer obstacles than land uses located away from the riparian corridor. However, during the growing season (i.e. in agricultural return flow) and in storm water runoff, distant land uses can become hydrologically connected to the stream, thus transporting nutrients from the hillslopes to the stream during these time periods.

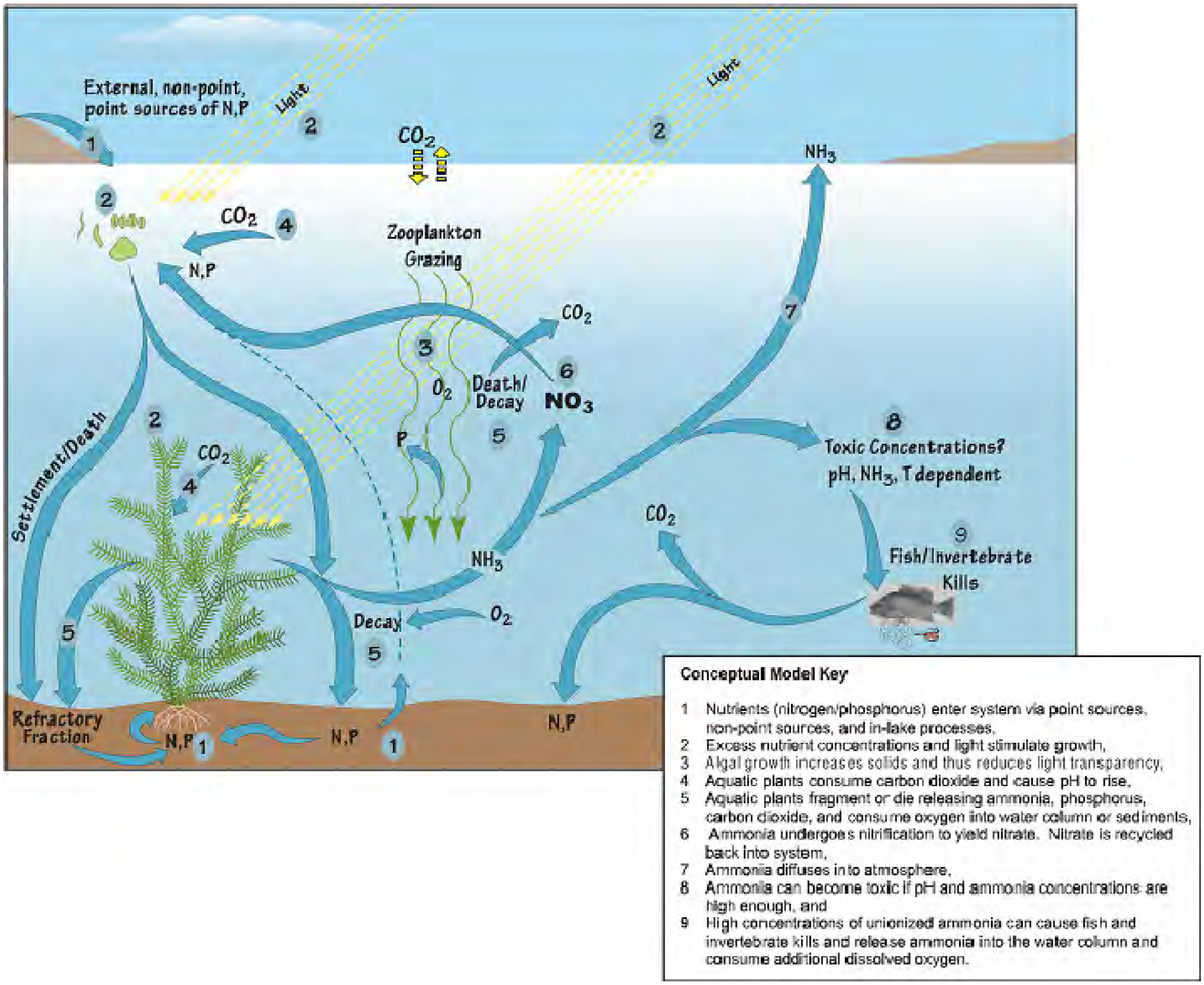


Figure 3.1 Nutrient Conceptual Model (USEPA 1999)

In addition to agriculture, there are several other human-related activities that influence nutrient concentrations in rivers and streams. Residential areas contribute nutrients from septic tanks (McQuillin 2004), landscape maintenance, as well as backyard livestock (e.g. cattle, horses) and pet wastes. Urban development contributes nutrients by disturbing the land and consequently increasing soil erosion, by increasing the impervious area within the watershed, and by directly applying nutrients to the landscape. Recreational activities such as hiking and biking can also contribute nutrients to the stream by reducing plant cover and increasing soil erosion (e.g. trail network, streambank destabilization), direct application of human waste, campfires and/or wildfires, and dumping trash near the riparian corridor.

Undeveloped, or natural, landscapes also can deliver nutrients to a waterbody through decaying plant material, soil erosion, and wild animal waste. Another geographically occurring nutrient source is atmospheric deposition, which adds nutrients directly to the waterbody through dryfall and rainfall. Atmospheric phosphorus and nitrogen can be found in both organic and inorganic particles, such as pollen and dust. The contributions from these natural sources are generally considered to represent background levels.

Water pollution caused by on-site septic systems is a widespread problem in New Mexico (McQuillan 2004). Septic system effluents have contaminated more water supply wells, and more acre-feet of ground water, than all other sources in the state combined. Groundwater contaminated by septic system effluent can discharge into streams gaining from groundwater inflow. Nutrients such as phosphorous and nitrogen released into gaining streams from aquifers contaminated by septic systems can contribute to eutrophic conditions.

Grazing appears to increase through the Valle Vidal Unit. Grazing has suppressed woody species in the Valle Vidal and subsequently continues to compromise riparian filtering functions. Erosion and sedimentation are likely the most significant source of nutrient loading in this watershed.

3.7 Margin of Safety (MOS)

TMDLs should reflect a MOS based on the uncertainty or variability in the data, the point and nonpoint source load estimates, and the modeling analysis. The MOS can be expressed either implicitly or explicitly. An implicit MOS is incorporated by making conservative assumptions in the TMDL analysis, such as allocating a conservative load to background sources. An explicit MOS is applied by reserving a portion of the TMDL and not allocating it to any other sources.

For these nutrient TMDLs, the margin of safety was developed using a combination of conservative assumptions and explicit recognition of potential errors. Therefore, this margin of safety is the sum of the following two elements:

- *Conservative Assumptions*

  Treating phosphorus and nitrogen as pollutants that do not readily degrade in the environment.

  Using the 4Q3 critical low flow “worst case scenario” to calculate the allowable loads.

- *Explicit recognition of potential errors*

  A level of uncertainty exists in water quality sampling. Accordingly, a conservative MOS for this element is **10 percent** of the TMDL.

3.8 Consideration of Seasonal Variability

Section 303(d)(1) of the CWA requires TMDLs to be "established at a level necessary to implement the applicable WQS with seasonal variation." Data used in the calculation of this TMDL were collected during spring, summer, and fall in order to ensure coverage of any potential seasonal variation in the system. Exceedences were observed from March through October, during all seasons, which captured flow alterations related to snowmelt, the growing season, and summer monsoonal rains. The critical condition used for calculating the TMDL was low-flow. Calculations made at the critical low-flow (4Q3), in addition to using other conservative assumptions as described in the previous section on MOS, should be protective of the water quality standards designed to preserve aquatic life in the stream. It was assumed that if critical conditions were met during this time, coverage of any potential seasonal variation would also be met.

3.9 Future Growth

Growth estimates by county are available from the New Mexico Bureau of Business and Economic Research. These estimates project growth to the year 2035. Growth estimates for Colfax and Taos Counties project a 14% and 25% growth rate, respectively, through 2035. However, there are no municipalities in the Valle Vidal and its status as an ONRW provides protection for the waters of the Valle Vidal under the New Mexico WQS-antidegradation policy. No development or population increases are expected in this watershed.

Nutrient loading in this watershed is due to both point and nonpoint sources. Since future projections indicate that nonpoint sources of nutrients will more than likely increase as the region continues to grow and develop, it is imperative that BMPs continue to be utilized in this watershed to improve road conditions and grazing allotments and adhere to SWPPP requirements related to construction and industrial activities covered under the general permit.

4.0 TEMPERATURE

Monitoring for temperature was conducted by SWQB in 2006. Based on available data, several exceedences of the New Mexico WQS for temperature were noted throughout the watershed (Figure 4.1). Thermographs were set to record once every hour for several months during the warmest time of the year (generally April or May through October). Thermograph data are assessed using Appendix C of the *State of New Mexico Procedures for Assessing Standards Attainment for the Integrated CWA §303(d)/§305(b) Water Quality Monitoring and Assessment Report [Assessment Protocol]* (NMED/SWQB 2009). Based on 2006 data, temperature listings were added to the *2010-2012 State of NM §303(d) List for Impaired Waters* (NMED/SWQB 2010b) for Gold Creek (Comanche Creek to headwaters), Holman Creek (Comanche Creek to headwaters), LaBelle Creek (Comanche Creek to headwaters), and North Ponil Creek (Seally Canyon to headwaters). McCrystal Creek (North Ponil to headwaters) was listed as impaired for temperature on the *2000-2002 State of NM §303(d) List for Impaired Waters* but the 2006 thermograph data indicated that the thermograph was buried and the data was not assessed. A TMDL will not be written for this AU until more recent data are available. Temperature data from 2006 were used to develop these TMDLs.

4.1 Target Loading Capacity

For this TMDL document, target values for temperature are based on the reduction in solar radiation necessary to achieve numeric criteria as predicted by a temperature model. The five temperature impaired AUs are classified in 20.6.4.123 NMAC and 20.6.4.309 NMAC and have the designated use of high quality coldwater aquatic life, the applicable temperature criterion is 20°C (68°F).

SWQB proposed revisions to select temperature criteria during the Triennial Review in December 2009. The revisions are effective as of April 2011 for CWA purposes and discussed in Section 2.3. The 2007 WQS defined the temperature criterion for HQCWAL as 20ºC (68ºF) or less whereas the new WQS define the temperature criterion for HQCWAL as 4T3 temperature 20ºC (68ºF), maximum temperature 23ºC (73ºF). The assessment units discussed in this section are classified in 20.6.4.123 or 20.6.4.309 NMAC with a designated use of HQCWAL. The definition of 4T3 in the revised WQS reads:

> *"4T3 temperature means the temperature not to be exceeded for four or more consecutive hours in a 24-hour period on more than three consecutive days."*

According to the 2009 Assessment Protocols (NMED/SWQB 2009), an AU is not supporting if

> "*Instantaneous (hourly) temperatures exceed 3.0ºC above the applicable criterion, or temperatures exceed the applicable criterion for four or more consecutive hours in a 24-hour cycle for more than three consecutive days".*

The 2007 Assessment Protocols were used to determine impairment of the waterbodies addressed in this section; thus a maximum temperature of 23ºC (73ºF) and the 4T3 temperature of 20ºC (68ºF) were applied. Although the revised WQS are only effective for State purposes at the time of the development of this document, the assessments and TMDL calculations included in this section will also be protective of the revised WQS.

Table 4.1 highlights the 2006 thermograph deployments. This TMDL addresses four reaches where temperatures exceeded the criterion.

<u>*Gold Creek (Comanche Creek to headwaters):*</u> One thermograph was deployed on this reach in 2006 above Comanche Creek (28GoldCr000.1). Recorded temperatures from April 21 through October 5 exceeded the HQCW aquatic life use criterion 188 of 4009 times (4.7%) with a maximum temperature of 25.4°C on June 23. An air thermograph was deployed at this station during 2006.

<u>*Holman Creek (Comanche Creek to headwaters):*</u> One thermograph was deployed on this reach in 2006 above Comanche Creek (28Holman000.1). Recorded temperatures from April 21 through October 5 exceeded the HQCW aquatic life use criterion 61 of 3,515 times (1.7%) with a maximum temperature of 25.1°C on July 26.

<u>*LaBelle Creek (Comanche Creek to headwaters):*</u> One thermograph was deployed on this reach in 2006 above Comanche Creek (28LaBell000.1). Recorded temperatures from April 21 through October 5 exceeded the HQCW aquatic life use criterion 271 of 4,013 times (6.8%) with a maximum temperature of 26°C on June 3.

<u>*North Ponil Creek (Seally Canyon to headwaters):*</u> One thermograph was deployed on this reach in 2006 above Seally Canyon (05NPonil023.2). Recorded temperatures from May 24 through October 6 exceeded the HQCW aquatic life use criterion 463 of 3,239 times (14%) with a maximum temperature of 29.3°C on July 16.

Table 4.1 Valle Vidal watershed thermograph sites (2006)

STORET ID	Site Name	Deployment Dates (2006)
28Comanc000.1	Comanche Creek above Costilla Creek [a]	22 May – 5 Oct
28RCosti032.5	Costilla Creek above Comanche Creek	22 May – 26 Sept
28Fernan000.1	Fernandez Creek above Comanche Creek	21 April - 5 Oct
28Gold000.1	Gold Creek above Comanche Creek [a]	21 April - 5 Oct
28Grassy000.1	Grassy Creek above Comanche Creek	21 April - 5 Oct
05Greenw000.1	Greenwood Creek above Middle Ponil Creek [a]	13 April - 6 Oct
28Holman000.1	Holman Creek above Comanche Creek	21 April - 5 Oct
28LaBell000.1	LaBelle Creek to Comanche Creek	21 April - 5 Oct
28LaCuev000.2	La Cueva Creek above Costilla Creek	21 April - 5 Oct
28LCosti000.1	Little Costilla Creek above Comanche Creek	21 April - 5 Oct
05McCrys002.0	McCrystal Creek at USFS campground *	13 April - 6 Oct
05MPonil016.2	Middle Ponil Creek above Greenwood Creek	24 May – 6 Oct

STORET ID	Site Name	Deployment Dates (2006)
05NPonil023.2	North Ponil Creek above Seally Canyon	24 May – 6 Oct
28Powder000.1	Powderhouse Creek above Costilla Creek	10 Aug - 25 Aug
05Seally000.2	Seally above North Ponil [a1]	13 April - 6 Oct
28VidalC000.1	Vidal Creek above Comanche Creek	13 April - 5 Oct

[a] air thermographs also deployed
[a1] air thermograph ONLY
* data indicate thermograph was buried, data not assessed

4.2 Flow

The critical flow condition for these TMDLs was obtained using a 4-day, 3-year low-flow frequency (4Q3) regression model. The 4Q3 is the minimum average four consecutive day flow that occurs with a frequency of at least once every 3 years. Low flow was chosen as the critical flow because of the negative effect low flows have on temperatures.

When available, USGS gages are used to estimate flow. There were no active gages in the Valle Vidal Watershed during the time of the water quality survey and data collection efforts. DFLOW 3.1b was not used due to the lack of USGS gage data, so Waltemeyer (2002) was used. The specific inflow and outflow values used in the Stream Segment Temperature (SSTEMP) model are discussed in detail in Appendix C.

4.3 Calculations

The SSTEMP Model, Version 2.0, developed by the USGS Biological Resource Division (Bartholow 2002) was used to predict stream temperatures based on watershed geometry, hydrology, and meteorology. The model predicts mean, minimum, and maximum daily water temperatures throughout a stream reach by estimating the heat gained or lost from a parcel of water as it passes through a stream segment (Bartholow 2002). The predicted temperature values are compared to actual thermograph readings measured in the field in order to calibrate the model. The SSTEMP model identifies current stream and/or watershed characteristics that control stream temperatures. The model also quantifies the maximum loading capacity of the stream to meet water quality criteria for temperature. This model is important for estimating the effect of changing controls, or constraints, (such as riparian grazing, stream channel alteration, and reduced streamflow) on stream temperature. The model can also be used to help identify possible implementation activities to improve stream temperature by targeting those factors causing impairment to the stream.

4.4 Waste Load Allocations and Load Allocations

4.4.1 Waste Load Allocation

There are no active point source contributions associated with these TMDLs. There are also no Municipal Separate Storm Sewer System (MS4) storm water permits in this AU. However, excess temperature loading may be a component of some storm water discharges covered under general NPDES permits, so the load from these dischargers should be addressed.

Storm water discharges from construction activities are transient because they occur mainly during the construction itself, and then only during storm events. Coverage under the National Pollutant Discharge Elimination System (NPDES) Construction General Permit (CGP) for construction sites greater than one acre requires preparation of a Storm Water Pollution Prevention Plan (SWPPP) that includes identification and control of all pollutants associated with the construction activities to minimize impacts to water quality. The current CGP also includes state-specific requirements to implement site-specific interim and permanent stabilization, managerial, and structural solids, erosion, and sediment control Best Management Practices (BMPs) and/or other controls. BMPs are designed to prevent to the maximum extent practicable an increase in sediment load to the water body or an increase in a sediment-related parameter, such as total suspended solids, turbidity, siltation, stream bottom deposits, etc. BMPs also include measures to reduce flow velocity during and after construction compared to pre-construction conditions to assure that waste load allocations (WLAs) or applicable water quality standards, including the antidegradation policy, are met. Compliance with a SWPPP that meets the requirements of the CGP is generally assumed to be consistent with this TMDL.

Storm water discharges from active industrial facilities are generally covered under the current NPDES Multi-Sector General Permit (MSGP). This permit also requires preparation of a SWPPP, which includes specific requirements to limit (or eliminate) pollutant loading associated with the industrial activities in order to minimize impacts to water quality. Compliance with a SWPPP that meets the requirements of the MSGP is generally assumed to be consistent with this TMDL.

It is not possible to calculate individual WLAs for facilities covered by these General Permits at this time using available tools. Loads that are in compliance with the General Permits are therefore currently included as part of the load allocation.

4.4.2 Load Allocation

Water temperature can be expressed as heat energy per unit volume. SSTEMP provides an estimate of heat energy expressed in joules per square meter per second ($j/m^2/s$) and Langley's per day. The following information relevant to the model runs used to determine temperature TMDLs is taken from the SSTEMP documentation (Bartholow 2002). Please refer to the SSTEMP User's Manual for complete text. Various notes have been added below in brackets to clarify local sources of input data.

The program will predict the minimum, mean, and maximum daily water temperature for the set of variables you provide (Figure 4.1). The theoretical basis for the model is strongest for the mean daily temperature. The maximum is largely an estimate and likely to vary widely with the maximum daily air temperature. The minimum is computed by subtracting the difference between maximum and mean from the mean; but the minimum is always positive (Bartholow 2002).

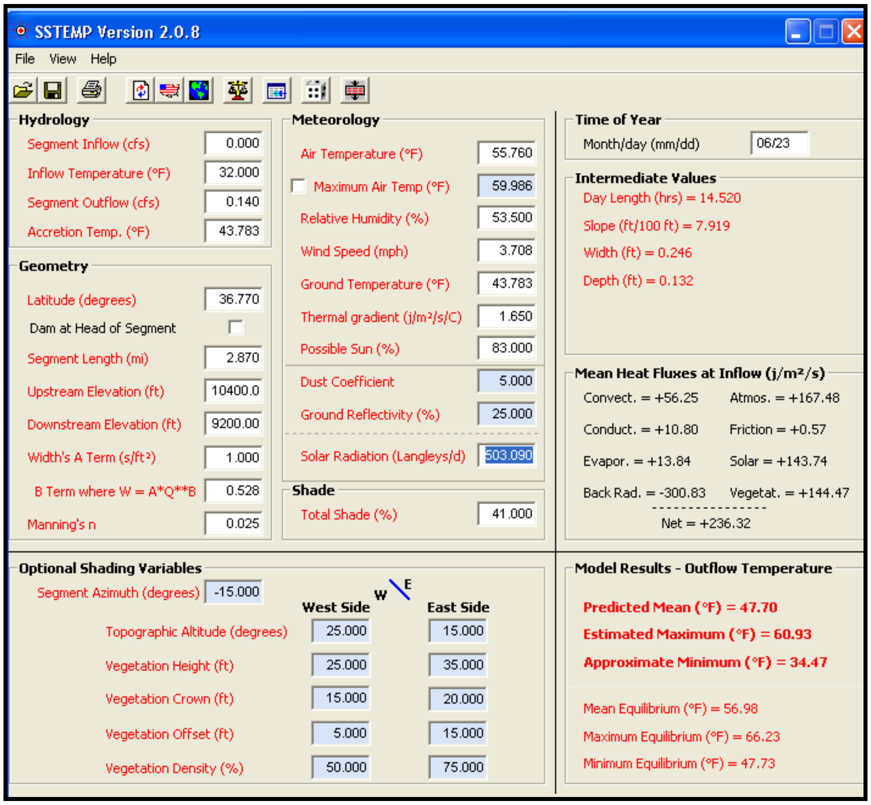


Figure 4.1 Example of SSTEMP input and output for Gold Creek

SSTEMP may be used to compute, one-at-a-time, the sensitivity input values. This simply increases and decreases most active input (i.e., non-grayed out values) by 10% and displays a screen for changes to mean and maximum temperatures. The "Relative Sensitivity" schematic graph that accompanies the display gives an indication of which variables most strongly influence the results (Bartholow 2002). See Figure 4.2 for an example of a sensitivity analysis.

4.4.2.1 Temperature Allocations as Determined by % Total Shade and Width-to-Depth Ratios

Tables 4.2-4.5 detail model outputs for segments on Gold Creek, Holman Creek, LaBelle Creek, and North Ponil Creek. SSTEMP was first calibrated against thermograph data to determine the standard error of the model. Initial conditions were determined. As the percent total shade was increased and the Width's A term was decreased, the maximum 24-hour temperature decreased until the segment-specific standard of 20ºC was achieved. The calculated 24-hour solar radiation component is the maximum solar load that can occur in order to meet the WQS (i.e., the target capacity). In order to calculate the actual load allocation (LA), the waste load allocation (WLA) and margin of safety (MOS) were subtracted from the target capacity (TMDL) following **Equation 4-1**.

$$WLA + LA + MOS = TMDL \qquad \text{(Eq. 4-1)}$$

The allocations for each assessment unit requiring a temperature TMDL are provided in the following tables.

Temperature Load Allocation for Gold Creek (Comanche Creek to headwaters)

For Gold Creek (Comanche Creek to headwaters), the WQS for temperature is achieved when the percent total shade is increased from 0 to 34%. According to the SSTEMP model, the actual LA of 144.71 $j/m^2/s$ is achieved when the shade is further increased to 41% (Table 4.2).

Table 4.2 SSTEMP Model Results for Gold Creek (Comanche Creek to headwaters)

<table>
<tr><th>WQS (HQCW Aquatic Life)</th><th>Model Run Date</th><th>Segment Length (miles)</th><th>Solar Radiation Component per 24-Hours (+/-)</th><th>% Total Shade</th><th>Modeled Temperature °C (24 hour)</th></tr>
<tr><td>20°C (68°F)</td><td>6/23/2006</td><td>2.87</td><td>Current Field Condition
+243.62
$j/m^2/s$</td><td>0</td><td>Minimum: 10.29
Mean: 17.19
Maximum: 24.09</td></tr>
<tr><td colspan="3" rowspan="3">TEMPERATURE ALLOCATIONS FOR Gold Creek (Comanche Creek to headwaters)
(a) 24-HOUR ACHIEVEMENT OF SURFACE WQS FOR TEMPERATURE

(b) 24-HOUR LOAD ALLOCATION (LA) NEEDED TO ACHIEVE SURFACE WQS WITH A 10% MARGIN OF SAFETY

Actual reduction in solar radiation necessary to meet surface WQS for temperature:

Current Condition – Load Allocation =

243.62 $j/m^2/s$ – 144.71 $j/m^2/s$

= 98.91 $j/m^2/s$</td><td>Run 1
+194.90
$j/m^2/s$</td><td>20</td><td>Minimum: 9.50
Mean: 15.62
Maximum: 21.74</td></tr>
<tr><td>Run 2
+160.79 (a)
$j/m^2/s$</td><td>34</td><td>Minimum: 8.98
Mean: 14.47
Maximum: 19.96</td></tr>
<tr><td>Actual LA

144.71 (b)
$j/m^2/s$</td><td>41</td><td>Minimum: 8.74
Mean: 13.88
Maximum: 19.02</td></tr>
</table>

Temperature Load Allocation for Holman Creek (Comanche Creek to headwaters)

For Holman Creek (Comanche Creek to headwaters), the WQS for temperature is achieved when the percent total shade is increased from 17 to 31.5%. According to the SSTEMP model, the actual LA of 124.04 $j/m^2/s$ is achieved when the shade is further increased to 38.5% (Table 4.3).

Table 4.3 SSTEMP Model Results for Holman Creek (Comanche Creek to headwaters)

<table>
<tr><th>WQS (Coldwater Aquatic Life)</th><th>Model Run Date</th><th>Segment Length (miles)</th><th>Solar Radiation Component per 24-Hours (+/-)</th><th>% Total Shade</th><th>Modeled Temperature °C (24 hour)</th></tr>
<tr><td>20°C (68°F)</td><td>7/26/2006</td><td>2.86</td><td>Current Field Condition
+166.99 $j/m^2/s$</td><td>17</td><td>Minimum: 10.59
Mean: 16.04
Maximum: 21.49</td></tr>
<tr><td colspan="3" rowspan="3">TEMPERATURE ALLOCATIONS FOR Holman Creek (Comanche Creek to headwaters)
[a] 24-HOUR ACHIEVEMENT OF SURFACE WQS FOR TEMPERATURE
[b] 24-HOUR LOAD ALLOCATION (LA) NEEDED TO ACHIEVE SURFACE WQS WITH A 10% MARGIN OF SAFETY

Actual reduction in solar radiation necessary to meet surface WQS for temperature:
Current Condition – Load Allocation =
166.99 $j/m^2/s$ – 124.04 $j/m^2/s$
= 42.95 $j/m^2/s$</td><td>Run 1
+160.96
$j/m^2/s$</td><td>20</td><td>Minimum: 10.52
Mean: 15.86
Maximum: 21.18</td></tr>
<tr><td>Run 2
+137.82 [a]
$j/m^2/s$</td><td>31.5</td><td>Minimum: 10.28
Mean: 15.12
Maximum: 19.97</td></tr>
<tr><td>Actual LA
124.04 [b]
$j/m^2/s$</td><td>38.5</td><td>Minimum: 10.13
Mean: 14.67
Maximum: 19.19</td></tr>
</table>

Temperature Load Allocation for LaBelle Creek (Comanche Creek to headwaters)

For LaBelle Creek (Comanche Creek to headwaters), the WQS for temperature is achieved when the percent total shade is increased from 9 to 22%. According to the SSTEMP model, the actual LA of 139.59 $j/m^2/s$ is achieved when the shade is further increased to 30% (Table 4.4).

Table 4.4 SSTEMP Model Results for LaBelle Creek (Comanche Creek to headwaters)

<table>
<tr><th>WQS (Coldwater Aquatic Life)</th><th>Model Run Date</th><th>Segment Length (miles)</th><th>Solar Radiation Component per 24-Hours (+/-)</th><th>% Total Shade</th><th>Modeled Temperature °C (24 hour)</th></tr>
<tr><td>20°C
(68°F)</td><td>6/3/2006</td><td>2.57</td><td>Current Field Condition
+180.95
$j/m^2/s$</td><td>9</td><td>Minimum: 9.78
Mean: 15.53
Maximum: 21.28</td></tr>
<tr><td colspan="3" rowspan="3">TEMPERATURE ALLOCATIONS FOR LaBelle Creek (Comanche Creek to headwaters)
(a) 24-HOUR ACHIEVEMENT OF SURFACE WQS FOR TEMPERATURE

(b) 24-HOUR LOAD ALLOCATION (LA) NEEDED TO ACHIEVE SURFACE WQS WITH A 10% MARGIN OF SAFETY

Actual reduction in solar radiation necessary to meet surface WQS for temperature:

Current Condition – Load Allocation =

180.95 $j/m^2/s$ – 139.59 $j/m^2/s$

= 41.36 $j/m^2/s$</td><td>Run 1
+169.02
$j/m^2/s$</td><td>15</td><td>Minimum: 9.64
Mean: 15.16
Maximum: 20.68</td></tr>
<tr><td>Run 2
+155.10 (a)
$j/m^2/s$</td><td>22</td><td>Minimum: 9.48
Mean: 14.72
Maximum: 19.97</td></tr>
<tr><td>Actual LA
+139.59 (b)
$j/m^2/s$</td><td>30</td><td>Minimum: 9.31
Mean: 14.22
Maximum: 19.13</td></tr>
</table>

Temperature Load Allocation for North Ponil Creek (Seally Canyon to headwaters)

For North Ponil Creek (Seally Canyon to headwaters), the WQS for temperature is achieved when the percent total shade is increased from 12 to 56%. According to the SSTEMP model, the actual LA of 115.17 j/m^2/s is achieved when the shade is further increased to 60.5% (Table 4.5).

Table 4.5 SSTEMP Model Results for North Ponil Creek (Seally Canyon to headwaters)

WQS (Coldwater Aquatic Life)	Model Run Date	Segment Length (miles)	Solar Radiation Component per 24-Hours (+/-)	% Total Shade	Modeled Temperature °C (24 hour)
20°C (68°F)	7/16/2006	7.03	**Current Field Condition** 255.93 j/m^2/s	12	Minimum: 12.95 Mean: 19.58 Maximum: 26.20
TEMPERATURE ALLOCATIONS FOR North Ponil Creek (Seally Canyon to headwaters) [(a)] **24-HOUR ACHIEVEMENT OF SURFACE WQS FOR TEMPERATURE** [(b)] 24-HOUR LOAD ALLOCATION (LA) NEEDED TO ACHIEVE SURFACE WQS WITH A 10% MARGIN OF SAFETY			**Run 1** +218.13 j/m^2/s	25	Minimum: 12.33 Mean: 18.97 Maximum: 24.51
			Run 2 +127.97 [(a)] j/m^2/s	56	Minimum: 10.97 Mean: 15.45 Maximum: 19.94
Actual reduction in solar radiation necessary to meet surface WQS for temperature: Current Condition – Load Allocation = 255.93 j/m^2/s – 115.17 j/m^2/s **=140.76 j/m^2/s**			**Actual LA** 115.17[(b)] j/m^2/s	60.5	Minimum: 10.78 Mean: 14.99 Maximum: 19.21

According to the Sensitivity Analysis feature of the model runs (Figure 4.2), mean daily air temperature had the greatest influences on the predicted outflow temperatures and total shade values have the greatest influence on temperature reduction.

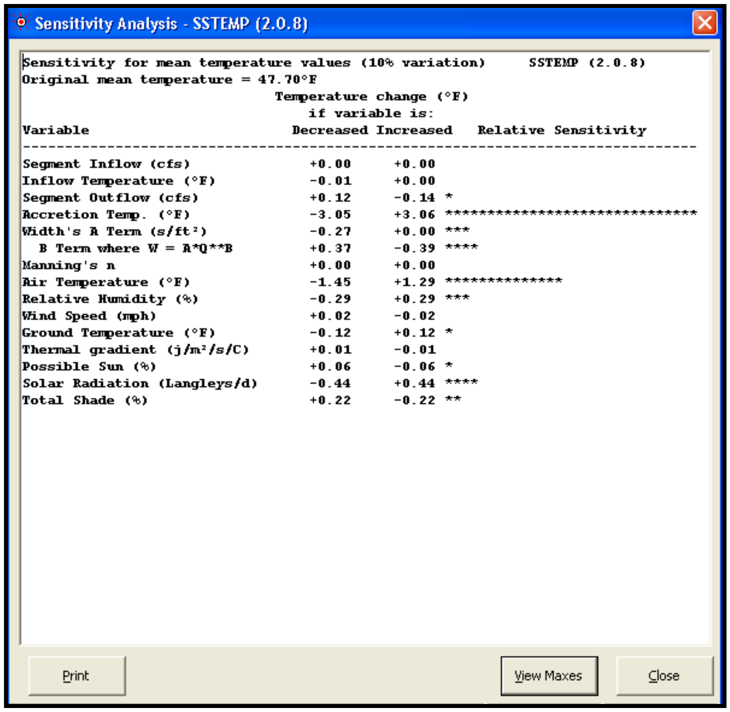


Figure 4.2 Example of SSTEMP sensitivity analysis for Gold Creek

The estimate of total shade used in the model calibration was based on densiometer readings (field notes) and examination of aerial photographs (see **Appendix C**). Target loads as determined by the modeling runs are summarized in Tables 4.2 – 4.5. The MOS is estimated to be 10% of the target load calculated by the modeling runs. Results are summarized in Table 4.6. Additional details on the MOS are presented in Section 4.7 below.

Table 4.6 Calculation of TMDLs for Temperature

Assessment Unit	WLA ($j/m^2/s$)	LA ($j/m^2/s$)	MOS (10%)[a] ($j/m^2/s$)	TMDL ($j/m^2/s$)
Gold Creek (Comanche Creek to headwaters)	0	144.71	16.08	160.79
Holman Creek (Comanche Creek to headwaters)	0	124.04	13.78	137.82
La Belle (Comanche Creek to headwaters)	0	139.59	15.51	155.10
North Ponil Creek (Seally Canyon to headwaters)	0	115.17	12.80	127.97

Notes: [a] Actual MOS values may be slightly greater than 10% because the final MOS is back calculated after the Total Shade value is increased enough to reduce the modeled solar radiation component to a value less than the target load minus 10%.

The load reductions that would be necessary to meet the target loads were calculated to be the difference between the calculated target load and the measured load (i.e., current field condition in Tables 4.2 – 4.5), and are shown in Table 4.7.

Table 4.7 Calculation of Load Reduction for Temperature

Location	Target Load[a] ($j/m^2/s$)	Measured Load ($j/m^2/s$)	Load Reduction ($j/m^2/s$)	Percent Reduction[b]
Gold Creek (Comanche Creek to headwaters)	144.71	243.62	98.91	41%
Holman Creek (Comanche Creek to headwaters)	124.04	166.99	42.95	26%
La Belle (Comanche Creek to headwaters)	139.59	180.95	41.36	23%
North Ponil Creek (Seally Canyon to headwaters)	115.17	255.93	140.96	55%

Notes: The MOS is not included in the load reduction calculations because it is a set aside value which accounts for any uncertainty, or variability, in TMDL calculations and therefore should not be subtracted from the measured load.
(a) Target Load = LA + WLA
(b) Percent reduction is the percent the existing measured load must be reduced to achieve the target load, and is calculated as follows: (Measured Load – Target Load) / Measured Load x 100.

4.5 Identification and Description of pollutant source(s)

SWQB fieldwork includes an assessment of the probable sources of impairment (Appendix B). The approach for identifying “Probable Sources of Impairment” was recently modified by SWQB to include additional input from a variety of stakeholders including landowners, watershed groups, and local, state, tribal and federal agencies. Probable Source Sheets are filled out by SWQB staff during watershed surveys and watershed restoration activities. The draft probable source list will be reviewed and modified, as necessary, with watershed group/ stakeholder input during the TMDL public meeting and comment period.

Table 4.8 Probable source summary for Temperature

Pollutant Sources	Magnitude[a]	Location		Probable Sources[b] (% from each)
Point:				
None	0	--------	0%	
Nonpoint:				
	243.62	Gold Creek (Comanche Creek to headwaters)	100%	Channelization, drought-related impacts, forest roads (road construction and use), low water crossing, natural sources, rangeland grazing, wildlife other than waterfowl.
	166.99	Holman Creek (Comanche Creek to headwaters)	100%	Channelization, drought-related impacts, forest roads (road construction and use), low water crossing, rangeland grazing.
	180.95	La Belle (Comanche Creek to headwaters)	100%	Channelization, drought-related impacts, forest roads (road construction and use), low water crossing, rangeland grazing, wildlife other than waterfowl.
	255.93	North Ponil Creek (Seally Canyon to headwaters)	100%	Habitat modifications (other than hydromodifications), natural sources, rangeland grazing, wildlife other than waterfowl, wildfire impacts, unknown, forest roads (road construction and use), low water crossing, drought-related impacts.

Notes:
[a] Measured Load as $j/m^2/s$. Expressed as solar radiation.
[b] From the 2010-2012 Integrated CWA §303(d)/305(b) List and staff input.

Although this procedure is subjective, SWQB feels that it provides the best available information for the identification of probable sources of impairment in a watershed. The list of "Probable Sources" is not intended to single out any single land owner or particular land management activity and generally includes several sources. Table 4.8 displays pollutant sources that may contribute to each segment as determined by field reconnaissance and evaluation. Probable sources of temperature impairments will be evaluated, refined, and changed as necessary through the Watershed-Based Plan (WBP).

4.6 Linkage of Water Quality and Pollutant Sources

Water temperature influences the metabolism, behavior, and mortality of fish and other aquatic organisms. Natural temperatures of a waterbody fluctuate daily and seasonally. These natural fluctuations do not eliminate indigenous populations, but may affect existing community structure and geographical distribution of species. In fact, such temperature cycles are often necessary to induce reproductive cycles and may regulate other aspects of life history (Mount

1969). Behnke and Zarn (1976) in a discussion of temperature requirements for endangered western native trout recognized that populations cannot persist in waters where maximum temperatures consistently exceed 21-22°C, but they may survive brief daily periods of higher temperatures (25.5-26.7°C). Anthropogenic impacts can lead to modifications of these natural temperature cycles, often leading to deleterious impacts on the fishery. Such modifications may contribute to changes in geographical distribution of species and their ability to persist in the presence of introduced species. Of all the environmental factors affecting aquatic organisms in a waterbody, temperature is always a factor. Heat, which is a quantitative measure of energy of molecular motion that is dependent on the mass of an object or body of water is fundamentally different than temperature, which is a measure (unrelated to mass) of energy intensity. Organisms respond to temperature, not heat.

A variety of factors impacts stream temperature (Figure 4.3). Decreased effective shade levels result from reduction of riparian vegetation. When canopy densities are compromised, thermal loading increases in response to the increase in incident solar radiation. Likewise, it is well documented that many past hydromodification activities have lead to channel widening. Wider stream channels also increase the stream surface area exposed to sunlight and heat transfer. Riparian area and channel morphology disturbances are attributed to past and to some extent current rangeland grazing practices that have resulted in reduction of riparian vegetation and streambank destabilization. These nonpoint sources of pollution primarily affect the water temperature through increased solar loading by: (1) increasing stream surface solar radiation and (2) increasing stream surface area exposed to solar radiation. Although climate, geographic location, and aspect are outside of human control, the condition of the riparian area, channel morphology and hydrology can be affected by land use activities. Specifically, the elevated summertime stream temperatures attributable to anthropogenic causes in the Valle Vidal result from the following conditions:

1. Channel widening (i.e., increased width to depth ratios) that has increased the stream surface area exposed to incident solar radiation,
2. Riparian vegetation disturbance that has reduced stream surface shading, riparian vegetation height and density, and
3. Reduced summertime base flows that result from instream withdrawals and/or inadequate riparian vegetation. Base flows are maintained with a functioning riparian system so that loss of a functioning riparian system may lower and sometimes eliminate baseflows. Although removal of upland vegetation has been shown, in some cases, to increase water yield, studies show that removal of riparian vegetation along the stream channel subjects the water surface and adjacent soil surfaces to wind and solar radiation, partially offsetting the reduction in transpiration with evaporation. In losing stream reaches, increased temperatures can result in increased streambed infiltration, which can result in lower base flow (Constantz et al. 1994).

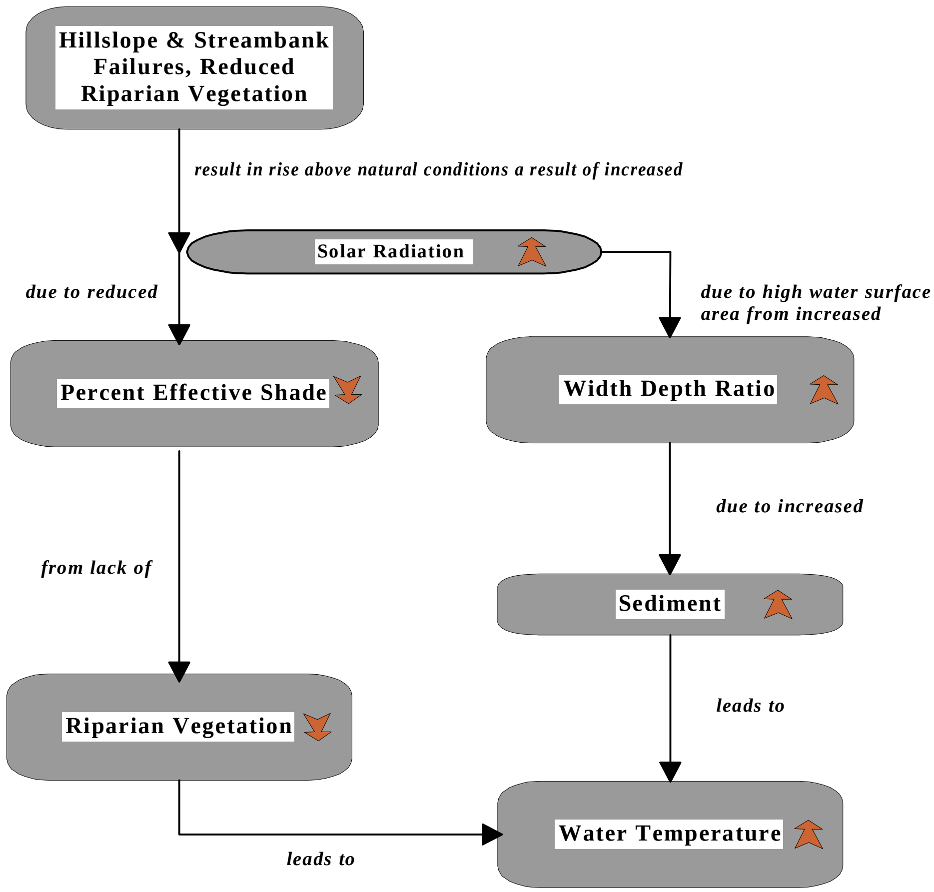


Figure 4.3 Factors That Impact Water Temperature

Temperature increases, as observed in SWQB thermograph data, show temperatures that exceed the State Standards for the protection of aquatic habitat, namely the HQCW aquatic life designated uses. Logging, mining, grazing and roads occurred in the Valle Vidal from the late 1800s through the mid-1900's. Legacy impacts have had approx 50 years to heal, but historic features are still visible throughout the landscape and continue to have an impact. Then in 2002, the Ponil Complex Fire burned 92,000 acres; much of the Middle Ponil and most of North Ponil watersheds. There is a high probability legacy impacts and fire are contributing sources. Elk influence is significant in the Valle Vidal where their heavy browsing can impede the recovery of woody vegetation. Low-water crossings in the Valle Vidal are typically wide and shallow-resulting in high surface area to unit volume ratio and higher heat exchange potential. Otherwise, roads could impact morphology (width to depth ratios) when yielding/delivering significant quantities of sediment. Grazing appears to increase through the Valle Vidal Unit. Grazing has suppressed woody species in the Valle Vidal and subsequently continues to compromise riparian filtering functions.

Analyses presented in these TMDLs demonstrate that the target loading capacities will result in attainment of New Mexico WQS. Specifically, the relationship between shade and water temperature was demonstrated through modeling analysis. Vegetation density increases will provide necessary shading, as well as encourage bank-building processes in severe hydrologic events. However, the presentation of percent total shade in Tables 4.2 – 4.5 is only one avenue which may be pursued to decrease water temperature and ultimately meet WQS. Changes in geomorphological parameters might also prove useful. SWQB encourages stakeholders to pursue whichever options seem to be the best fit for each particular watershed or project with the ultimate goal being that the stream temperature meets the WQS.

Where available data are incomplete or where the level of uncertainty in the characterization of sources is large, the recommended approach to TMDL assignments requires the development of allocations based on estimates utilizing the best available information.

4.7 Margin of Safety (MOS)

The CWA requires that each TMDL be calculated with a MOS. This statutory requirement that TMDLs incorporate a MOS is intended to account for uncertainty in available data or in the actual effect controls will have on loading reductions and receiving water quality. A MOS may be expressed as unallocated assimilative capacity or implicit conservative analytical assumptions used for calculation of the loading capacity, WLAs, and LAs (e.g., derivation of numeric targets, modeling assumptions or effectiveness of proposed management actions). The MOS may also be explicitly stated as an added separate quantity in the TMDL calculation.

For this TMDL, there were no MOS adjustments for point sources since there are none.

In order to develop this temperature TMDL, the following conservative assumptions were used to parameterize the model:

- Data from the warmest time of the year were used in order to capture the seasonality of temperature exceedences.
- Critical upstream and downstream low flows were used because assimilative capacity of the stream to absorb and disperse solar heat is decreased during these flow conditions.
- Low flow was modeled using formulas developed by the USGS. One formula (Thomas et al. 1997) is recommended when the ratio between the gaged watershed area and the ungaged watershed area is between 0.5 and 1.5. When the ratio is outside of this range, a different regression formula is used (Waltemeyer 2002). See **Appendix C** for details.

As detailed in **Appendix C,** a variety of hydrologic, geomorphologic, and meteorological data were used to parameterize the SSTEMP model. Because of the quality of data and information that was put into this model and the continuous field monitoring data used to verify these model outputs, an explicit MOS of 10% is assigned to this TMDL.

4.8 Consideration of seasonal variation

Section 303(d)(1) of the CWA requires TMDLs to be "…established at a level necessary to implement the applicable WQS with seasonal variations". Both stream temperature and flow vary seasonally and from year to year. Water temperatures are coolest in winter and early spring months.

Thermograph records show that temperatures exceed State of New Mexico WQS in summer and early fall. Warmest stream temperatures corresponded to prolonged solar radiation exposure, warmer air temperature, and low flow conditions. These conditions occur during late summer and early fall and promote the warmest seasonal instream temperatures. It is assumed that if critical conditions are met, coverage of any potential seasonal variation will also be met.

4.9 Future Growth

Growth estimates by county are available from the New Mexico Bureau of Business and Economic Research. These estimates project growth to the year 2035. Growth estimates for Colfax and Taos Counties project a 14% and 25% growth rate, respectively, through 2035. However, there are no municipalities in the Valle Vidal and its status as an ONRW provides protection for the waters of the Valle Vidal under the New Mexico WQS-antidegradation policy. No development or population increases are expected in this watershed.

Estimates of future growth are not anticipated to lead to a significant increase in water temperature that cannot be controlled with best management practices (BMPs) in this watershed. However, it is imperative that BMPs continue to be utilized in this watershed to improve road conditions and grazing allotments and adhere to SWPPP requirements related to construction and industrial activities covered under the general permit.

5.0 MONITORING PLAN

Pursuant to CWA Section 106(e)(1), the SWQB has established appropriate monitoring methods, systems and procedures in order to compile and analyze data on the quality of the surface waters of New Mexico. In accordance with the New Mexico Water Quality Act, the SWQB has developed and implements a comprehensive water quality monitoring strategy for the surface waters of the State.

The monitoring strategy establishes the methods of identifying and prioritizing water quality data needs, specifies procedures for acquiring and managing water quality data, and describes how these data are used to progress toward three basic monitoring objectives: to develop water quality-based controls, to evaluate the effectiveness of such controls, and to conduct water quality assessments. SWQB revised its 10-year monitoring and assessment strategy (NMED/SWQB 2010a) and submitted it to EPA Region 6 for review on March 23, 2010. The strategy details both the extent of monitoring that can be accomplished with existing resources plus expanded monitoring strategies that could be implemented given additional resources. According to the watershed rotation described in the strategy, the next time SWQB will conduct a water quality survey in the Valle Vidal waters in 2016-2017.

The SWQB utilizes a rotating basin system approach to water quality monitoring. In this system, a select number of watersheds are intensively monitored each year with an established return frequency of approximately every eight years. The next scheduled monitoring date for the Valle Vidal waters in 2016-2017. The SWQB maintains current quality assurance and quality control plans to cover all monitoring activities. This document, called the QAPP, is updated and certified annually by USEPA Region 6. In addition, the SWQB identifies the data quality objectives required to provide information of sufficient quality to meet the established goals of the program. Current priorities for monitoring in the SWQB are driven by the CWA Section 303(d) list of streams requiring TMDLs. Short-term efforts were directed toward those waters that are on the USEPA TMDL consent decree list (U.S. District Court for the District of New Mexico 1997), however NMED/SWQB completed the final remaining TMDL on the consent decree in December 2006 and USEPA approved this TMDL in August 2007. The U.S. District Court dismissed the Consent Decree on April 21, 2009.

Once assessment monitoring is completed, those reaches showing impacts and requiring a TMDL will be targeted for more intensive monitoring. The methods of data acquisition include fixed-station monitoring, intensive surveys of priority assessment units (including biological assessments), and compliance monitoring of industrial, federal, and municipal dischargers, as specified in the SWQB Standard Operating Procedures (NMED/SWQB 2011).

Long-term monitoring for assessments will be accomplished through the establishment of sampling sites that are representative of the waterbody and which can be revisited approximately every eight years. This information will provide time relevant information for use in CWA Section 303(d) listing and 305(b) report assessments and to support the need for developing TMDLs. The approach provides:

- a systematic, detailed review of water quality data which allows for a more efficient use of limited monitoring resources;

- information at a scale where implementation of corrective activities is feasible;
- an established order of rotation and predictable sampling in each basin which allows for enhanced coordinated efforts with other programs; and
- program efficiency and improvements in the basis for management decisions.

It should be noted that a watershed would not be ignored during the years in between water quality surveys. The rotating basin program will be supplemented with other data collection efforts such as the funding of long-term USGS water quality gaging stations for long-term trend data and on-going studies being performed by the USGS and USEPA. Data will be analyzed and field studies will be conducted to further characterize acknowledged problems and TMDLs will be developed and implemented accordingly. Both long-term and intensive field studies contribute to the State's Integrated §303(d)/§305(b) listing process for waters requiring TMDLs.

6.0 IMPLEMENTATION OF TMDLS

6.1 Point Sources – NPDES Permitting

There are no NPDES permits and thus no WLAs assigned in this TMDL.

6.2 Nonpoint Sources – WBP and BMP Coordination

Public awareness and involvement will be crucial to the successful implementation of these plans and improved water quality. Staff from SWQB will work with stakeholders to provide guidance in developing Watershed-Based Plans (WBPs) for each impaired stream segment for which a TMDL has been prepared. A WBP is a written plan intended to provide a long-range vision for various activities and management of resources in a watershed. It describes opportunities for private landowners and public agencies to reduce and prevent nonpoint source impacts to water quality. These long-range strategies will become instrumental in coordinating efforts to achieve water quality standards in the watershed. A WBP is essentially an Implementation Plan, or Phase Two of the TMDL process. The completion of the TMDLs and WBPs leads to the development of on-the-ground projects to address surface water impairments in the watershed.

NMED conducts an annual request for proposals to identify watershed-based planning projects for support with incremental funds appropriated by Congress under Section 319(h) of the Clean Water Act. These projects develop WBPs which meet the planning elements identified by EPA in the *Nonpoint Source Program and Grants Guidelines for States and Territories* (Fed. Reg., October 23, 2003). During the watershed-based planning process, SWQB staff provides technical support related to monitoring, pollutant source identification, selection and application of BMPs, and other aspects of the planning elements. Stakeholder public outreach and involvement in the implementation of this TMDL will be ongoing. Stakeholder involvement is a key aspect of the watershed-based planning process.

WBPs describe work which could be implemented under various programs and organizations with authority or responsibility related to water quality. Section 319 funding is one source of such funding. NMED conducts a second annual request for proposals for projects which implement components of WBPs.

Section 319 funds made available through the requests for proposals are available on a competitive basis to all private, for-profit and nonprofit organizations that are authenticated legal entities, or governmental jurisdictions including: cities, counties, tribal entities, Federal agencies, or agencies of the State. Funded projects require a non-federal match of 40% of the total project cost, consisting of funds and/or in-kind services. Further information on funding from the CWA §319 (h) can be found at the SWQB website: http://www.nmenv.state.nm.us/swqb/.

6.3 Time Line

Table 6.1 details the proposed implementation timeline. A WBP is currently being developed for the Cimarron Watershed and the project scope includes listed reaches and tributaries of Middle and North Ponil Creeks.

Table 6.1 Proposed Implementation Timeline

Implementation Actions	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8
Public Outreach and Involvement	X	X	X	X	X	X	X	X
TMDL Development	X							
WBP Development				X	X	X		
Revise any NPDES permits as necessary			X					X
Establish Performance Targets				X				
Secure Funding			X	X				
Implement Management Measures (BMPs)			X	X	X	X	X	X
Monitor BMPs			X	X	X			
Determine BMP Effectiveness					X	X	X	X
Re-evaluate Performance Targets						X	X	X

6.4 Other Funding Opportunities and Restoration Efforts in the Valle Vidal Basin

Several other sources of funding exist to address impairments discussed in this TMDL document. One of the elements of a watershed-based plan is, “an estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon”, to implement the plan. They can also provide matching funds for appropriate CWA §319(h) projects using state revolving fund monies. The USDA Environmental Quality Incentive Program (EQIP) program can provide assistance to agricultural producers in the basin. The USDA Forest Service aligns their mission to protect lands they manage with the TMDL process, and are another source of assistance. The BLM has several programs in place to provide assistance to improve unpaved roads and grazing allotments.

7.0 APPLICABLE REGULATIONS and STAKEHOLDER ASSURANCES

New Mexico's Water Quality Act (Act) authorizes the WQCC to "promulgate and publish regulation to prevent or abate water pollution in the state" and to require permits. The Act authorizes a constituent agency to take enforcement action against any person who violates a water quality standard. Several statutory provisions on nuisance law could also be applied to NPS water pollution. The Water Quality Act also states in §74-6-12(a):

> *The Water Quality Act (this article) does not grant to the commission or to any other entity the power to take away or modify the property rights in water, nor is it the intention of the Water Quality Act to take away or modify such rights.*

In addition, the State of New Mexico Surface Water Quality Standards (see Subsection C of 20.6.4.6 NMAC) (NMAC 2007) states:

> *Pursuant to Subsection A of Section 74-6-12 NMSA 1978, this part does not grant to the water quality control commission or to any other entity the power to take away or modify property rights in water.*

New Mexico policies are in accordance with the federal Clean Water Act §101(g):

> *It is the policy of Congress that the authority of each State to allocate quantities of water within its jurisdiction shall not be superseded, abrogated or otherwise impaired by this Act. It is the further policy of Congress that nothing in this Act shall be construed to supersede or abrogate rights to quantities of water which have been established by any State. Federal agencies shall co-operate with State and local agencies to develop comprehensive solutions to prevent, reduce and eliminate pollution in concert with programs for managing water resources.*

New Mexico's CWA §319 Program has been developed in a coordinated manner with the State's 303(d) process. All 319 watersheds that are targeted in the annual RFP process coincide with the State's biennial impaired waters list as approved by USEPA. Section 319 funds are further prioritized to target impaired waters with developed TMDLs, and a smaller category of impaired waters which do not require TMDLs because the impairment is considered to be related to flow rather than excessive pollutant loading. The State has given a high priority for funding, assessment, and restoration activities to these watersheds.

As a constituent agency, NMED has the authority under Chapter 74, Article 6-10 NMSA 1978 to issue a compliance order or commence civil action in district court for appropriate relief if NMED determines that actions of a "person" (as defined in the Act) have resulted in a violation of a water quality standard including a violation caused by a NPS. The NMED NPS water quality management program has historically strived for and will continue to promote voluntary compliance to NPS water pollution concerns by utilizing a voluntary, cooperative approach. The State provides technical support and grant monies for implementation of BMPs and other NPS prevention mechanisms through §319 of the Clean Water Act. Since portions of this TMDL will be implemented through NPS control mechanisms, the New Mexico Watershed Protection Program will target efforts to this and other watersheds with TMDLs.

In order to obtain reasonable assurances for implementation in watersheds with multiple landowners, including federal, state and private land, NMED has established Memoranda of Understanding (MOUs) with various federal agencies, in particular the Forest Service and the Bureau of Land Management. MOUs have also been developed with other state agencies, such as the New Mexico Department of Transportation. These MOUs provide for coordination and consistency in dealing with NPS issues.

The time required to attain standards for all reaches is estimated to be approximately 10-20 years. This estimate is based on a five-year time frame implementing several watershed projects that may not be starting immediately or may be in response to earlier projects. Stakeholders in this process will include SWQB, and other parties identified in the WBP. The cooperation of watershed stakeholders will be pivotal in the implementation of these TMDLs as well.

8.0 PUBLIC PARTICIPATION

Public participation was solicited in development of this TMDL (see **Appendix D**). The draft TMDL will be made available for a 30-day comment period beginning on June 6, 2011. No written public comments were received. The draft document notice of availability was extensively advertised via newsletters, email distribution lists, webpage postings (http://www.nmenv.state.nm.us), and press releases to area newspapers. Meetings will be held in Tucumcari, Mora, and Raton during the public comment period.

The TMDL was approved by the Water Quality Control Commission on Friday, September 30, 2011, and now the next step for public participation is in activities as described in Section 8.0 with watershed protection projects including those that may be funded by Clean Water Act Section 319(h) grants.

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APPENDIX A
CONVERSION FACTOR DERIVATION

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Flow (as million gallons per day [mgd]) and concentration values (milligrams per liter [mg/L]) must be multiplied by a conversion factor in order to express the load in units "pounds per day." The following expressions detail how the conversion factor was determined:

TMDL Calculation:

$$Flow\,(mgd) \times Concentration\left(\frac{mg}{L}\right) \times ConversionFactor\left(\frac{L-lb}{gal-mg}\right) = Load\left(\frac{lb}{day}\right)$$

Conversion Factor (CF) Derivation:

$$CF = 10^6 \times \frac{3.785\,L}{gal} \times \frac{1\,lb}{454{,}000\,mg} = 8.34\,\frac{L-lb}{gal-mg}$$

Flow (as million gallons per day [mgd]) and concentration values (micrograms per liter [ug/L]) must be multiplied by a conversion factor in order to express the load in units "pounds per day." The following expressions detail how the conversion factor was determined:

TMDL Calculation:

$$Flow\,(mgd) \times Concentration\left(\frac{ug}{L}\right) \times ConversionFactor\left(\frac{L-lb}{gal-ug}\right) = Load\left(\frac{lb}{day}\right)$$

Conversion Factor (CF) Derivation:

$$CF = 10^6 \times \frac{3.785\,L}{gal} \times \frac{1\,lb}{454{,}000{,}000\,ug} = 0.00834\,\frac{L-lb}{gal-ug}$$

APPENDIX B
PROBABLE SOURCES OF IMPAIRMENT

“Sources” are defined as activities that may contribute pollutants or stressors to a water body (USEPA 1997). The list of “Probable Sources of Impairment” in the Integrated 303(d)/305(b) List, Total Maximum Daily Load documents (TMDL’s), and Watershed-Based Plans (WBP’s) is intended to include any and all activities that could be contributing to the identified cause of impairment. Data on Probable Sources is routinely gathered by Monitoring and Assessment Section staff and Watershed Protection Section staff during water quality surveys and watershed restoration projects and is housed in the Assessment Database (ADB version 2). ADB was developed by USEPA to help states manage information on surface water impairment and to generate §303(d)/ §305(b) reports and statistics. More specific information on Probable Sources of Impairment is provided in individual watershed planning documents (e.g., TMDL’s, WBP’s, etc) as they are prepared to address individual impairments by assessment unit.

USEPA through guidance documents strongly encourages states to include a list of Probable Sources for each listed impairment. According to the 1998 305(b) report guidance, “…, states must always provide aggregate source category totals…” in the biennial submittal that fulfills CWA section 305(b)(1)(C) through (E) (USEPA 1997). The list of “Probable Sources” is not intended to single out any particular land owner or single land management activity and has therefore been labeled “Probable” and generally includes several sources for each known impairment.

The approach for identifying “Probable Sources of Impairment” was recently modified by SWQB. Any new impairment listing will be assigned a Probable Source of “Source Unknown.” Probable Source Sheets will continue to be filled out during watershed surveys and watershed restoration activities by SWQB staff. Information gathered from the Probable Source Sheets will be used to generate a draft Probable Source list in consequent TMDL planning documents. These draft Probable Source lists will be finalized with watershed group/stakeholder input during the pre-survey public meeting, TMDL public meeting, WBP development, and various public comment periods. The final Probable Source list in the approved TMDL will be used to update the subsequent Integrated List.

Literature Cited:

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Figure B1. Probable Source Development Process and Public Particpation Flowchart

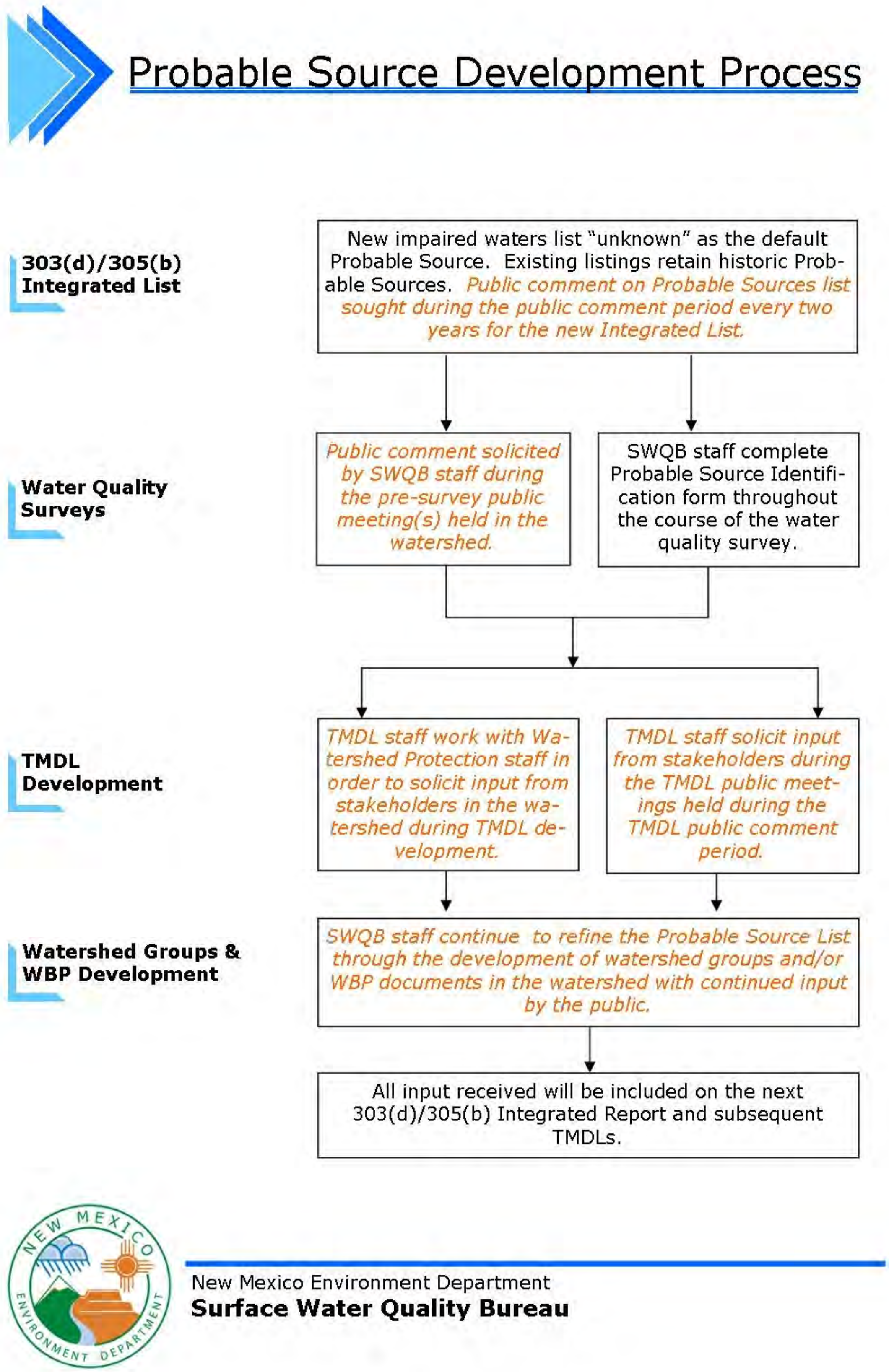

Figure B2. Probable Source Identification Sheet for the Public

Help Us Identify Probable Sources of Impairment

Name:
Phone Number (optional):
Email or Mailing Address (optional):
Date:
Waterbody Name/ Watershed Name/ Location of concern:

From the list below, please check the items you believe are sources of water quality impairment in the watershed or waterbody of concern. In the spaces next to each item you check, please use the following scale to indicate how much of a concern that item is to you by specifying a number between 1 and 3.

(1 - Slight Concern) (2 – Moderate Concern) (3 – High Concern)

✓	ACTIVITY	Scale of Concern			✓	ACTIVITY	Scale of Concern		
☐	Feedlots	1	2	3	☐	Pavement and Other Impervious Surfaces	1	2	3
☐	Livestock Grazing	1	2	3	☐	Roads/Bridges/Culverts	1	2	3
☐	Agriculture	1	2	3	☐	Habitat Modification(s)	1	2	3
☐	Flow Alterations (water withdrawal)	1	2	3	☐	Mining/Resource Extraction	1	2	3
☐	Stream/River Modification(s)	1	2	3	☐	Logging/Forestry Operations	1	2	3
☐	Storm Water Runoff	1	2	3	☐	Housing or Land Development	1	2	3
☐	Flooding	1	2	3	☐	Exotic species	1	2	3
☐	Landfill(s)	1	2	3	☐	Waterfowl	1	2	3
☐	Industry/Wastewater Treatment Plant	1	2	3	☐	Wildlife and domesticated animals other than waterfowl	1	2	3
☐	Inappropriate Waste Disposal	1	2	3	☐	Recreational Use	1	2	3
☐	Improperly maintained Septic Systems	1	2	3	☐	Natural Disturbances *(please describe)*	1	2	3
☐	Other: *(please describe)*	1	2	3	☐	Other: *(please describe)*	1	2	3

Comments:

Figure B3. Probable Source Identification Sheet for NMED and Other Agencies

16 Mar 09
Ver. 2

Probable Source Field Sheet & Site Condition Class Verification

Station ID:	Station Name/Description:	
Field Crew:	Comments:	
Date:	Watershed protection staff reviewer:	Date of WPS review:
WQS Segment from 20.6.4 NMAC:	Assessment Unit:	

Score the proximity and certainty of occurance of the following activities in the watershed upstream of the site. Consult with the appropriate staff at NMED and other agencies to score shaded cells. Fill out after recon during 1st or 2nd site visit, review and revise at the end of the survey, and have it reviewed by Watershed Protection Staff with knowledge of the particular watershed. Maintain completed forms in Survey Binder.

Activity Checklist

Agriculture				
Permitted CAFOs	0	1	3	5
Crop Production (Cropland or Dry Land)	0	1	3	5
Drains	0	1	3	5
Irrigated Crop Production (Irrigation Equip)	0	1	3	5
Permitted Aquaculture	0	1	3	5
Other:	0	1	3	5
Rangeland				
Livestock Grazing or Feeding Operation	0	1	3	5
Rangeland Grazing (dispersed)	0	1	3	5
Other:	0	1	3	5
Industrial/ Municipal				
Industrial Stormwater Discharge (permitted)	0	1	3	5
Storm water Runoff due to Construction	0	1	3	5
Industrial Point Source Discharge	0	1	3	5
Landfill	0	1	3	5
Municipal Point Source Discharge	0	1	3	5
On-Site Treatment Systems (Septic, etc.)	0	1	3	5
Pavement/ /Impervious Surfaces	0	1	3	5
Inappropriate Waste Disposal	0	1	3	5
RCRA/Superfund Site	0	1	3	5
Residences/Buildings	0	1	3	5
Site Clearance (Land Development)	0	1	3	5
Urban Runoff/Storm Sewers	0	1	3	5
Power Plants	0	1	3	5
Other:	0	1	3	5
Resource Extraction				
Abandoned Mines (Inactive)/Tailings	0	1	3	5
Acid Mine Drainage	0	1	3	5
Active Mines (Placer/Potash/Other -- circle)	0	1	3	5
Oil/Gas Activities (Permitted/Legacy – circle)	0	1	3	5
Reclamation of Inactive Mines	0	1	3	5
Other:	0	1	3	5
Roads				
Bridges/Culverts/RR Crossings	0	1	3	5
Low Water Crossing	0	1	3	5
Paved Roads	0	1	3	5
Gravel or Dirt Roads	0	1	3	5
Other:	0	1	3	5

Silviculture				
Logging Ops – Active Harvesting	0	1	3	5
Logging Ops – Legacy	0	1	3	5
Fire Suppression (Thinning/Chemicals)	0	1	3	5
Other:	0	1	3	5
Hydromodifications				
Channelization	0	1	3	5
Dams/Diversions	0	1	3	5
Draining/Filling Wetlands	0	1	3	5
Dredging	0	1	3	5
Irrigation Return Drains	0	1	3	5
Riprap/Wall/Dike/Jetty Jack -- circle	0	1	3	5
Flow Alteration (from Water Diversions/Dam Ops – circle)	0	1	3	5
Highway/Road/Bridge Runoff	0	1	3	5
Other:	0	1	3	5
Miscellaneous				
Angling Pressure	0	1	3	5
Dumping/Garbage/Trash/Litter	0	1	3	5
Exotic Plant Species	0	1	3	5
Fish Stocking	0	1	3	5
Hiking Trails	0	1	3	5
Campgrounds (Dispersed/Defined – circle)	0	1	3	5
Surface Films/Odors	0	1	3	5
Pesticide Application (Algaecide/Insecticide)	0	1	3	5
Waste From Pets (high concentration)	0	1	3	5
Other:	0	1	3	5
Habitat Modification				
Exotics Removal	0	1	3	5
Incised	0	1	3	5
Mass Wasting	0	1	3	5
Restoration	0	1	3	5
Other:	0	1	3	5
Natural Disturbance or Occurrence				
Waterfowl	0	1	3	5
Drought-related Impacts	0	1	3	5
Watershed Runoff Following Forest Fire	0	1	3	5
Recent Bankfull or Overbank Flows	0	1	3	5
Wildlife other than Waterfowl	0	1	3	5
Other Natural Sources:	0	1	3	5

Legend – Proximity Score

Activity believed to be Absent	0
Activity believed to be present in Watershed	1
Activity observed or known to be present within 1 km of the channel	3
Activity observed or known to be present in the riparian zone	5

APPENDIX C
HYDROLOGY, GEOMETRY, AND METEROLOGICAL INPUT DATA FOR SSTEMP

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LIST OF ACRONYMS

4Q3	Four-consecutive day discharge that has a recurrence interval of three years
cfs	Cubic Feet per Second
GIS	Geographic Information Systems
GPS	Global Positioning System
IOWDM	Input and Output for Watershed Data Management
mi^2	Square Miles
^oC	Degrees Celsius
SEE	Standard Error of Estimate
SSTEMP	Stream Segment Temperature
SWSTAT	Surface-Water Statistics
TMDL	Total Maximum Daily Load
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
WinXSPRO	Windows-Based Stream Channel Cross-Section Analysis

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C 1.0 INTRODUCTION

This appendix provides site-specific hydrology, geometry, and meteorological data for input into the Stream Segment Temperature (SSTEMP) Model (Bartholow 2002). Hydrology variables include segment inflow, inflow temperature, segment outflow, and accretion temperature. Geometry variables are latitude, segment length, upstream and downstream elevation, Width's A-term, Width's B-term, and Manning's n. Meteorological inputs to SSTEMP Model include air temperature, relative humidity, windspeed, ground temperature, thermal gradient, possible sun, dust coefficient, ground reflectivity, and solar radiation. In the following sections, these parameters are discussed in detail for each assessment unit to be modeled using SSTEMP Model.

The assessment units were modeled on the day of the maximum recorded thermograph measurement. The assessment units and modeled dates are defined as follows:

Table C.1 Assessment Units and Modeled Dates

Assessment Unit ID	Assessment Unit Description	Modeled Date
NM-2120.A_835	Gold Creek (Comanche Creek to headwaters)	6/23/2006
NM-2120.A_837	Holman Creek (Comanche Creek to headwaters)	7/26/2006
NM-2120.A_839	LaBelle Creek (Comanche Creek to headwaters)	6/3/2006
NM-2306.A_162	North Ponil Creek (Seally Canyon to headwaters)	7/16/2006

C 2.0 HYDROLOGY

C2.1 Segment Inflow

This parameter is the *mean daily* flow at the top of the stream segment. If the segment begins at an effective headwater, the flow is entered into SSTEMP Model as zero. Flow data from USGS gages are generally used to calculate 4Q3 flows, but no gages were available for these waterbodies.

Discharges for ungaged sites on gaged streams were estimated based on methods published by Thomas *et al.* (1997). If the drainage area of the ungaged site is between 50 and 150 percent of the drainage area of the gaged site, the following equation is used:

$$Q_u = Q_g \left(\frac{A_u}{A_g} \right)^{0.5}$$

where,

Q_u = Area weighted 4Q3 at the ungaged site (cubic feet per second [cfs])
Q_g = 4Q3 at the gaged site (cfs)
A_u = Drainage area at the ungaged site (square miles [mi^2])
A_g = Drainage area at the gaged site (mi^2)

Drainage areas for assessment units to which this method was applied are summarized in the following table:

Table C.2 Drainage Areas for Estimating Flow by Drainage Area Ratios

Assessment Unit	USGS Gage	Drainage Area from Gage (mi^2)	Drainage Area from Top of AU (mi^2)	Drainage Area from Bottom of AU (mi^2)	Ratio of DA of Ungaged (upstream) to Gaged Site	Ratio of DA of Ungaged (downstream) to Gaged Site
NM-2120.A_835	(a)	--	0.2[b]	2.21	— [c]	-- [c]
NM-2120.A_837	(a)	--	0.1[b]	1.89	— [c]	-- [c]
NM-2120.A_839	(a)	--	0.1 [b]	1.73	— [c]	-- [c]
NM-2306.A_162	(a)	--	0.2[b]	36.84	— [c]	-- [c]

Notes:

(a) Regression method developed by Waltemeyer (2002) was used to estimate flows since this is an ungaged stream.

(b) Assessment unit begins at headwaters.

(c) The method developed by Thomas et al. (1997) is not applicable because the drainage area of the ungaged site is less than 50 percent of the drainage area of the gaged site. Therefore, the method developed by Waltemeyer (2002) was used to estimate flows for this assessment unit.

mi^2 = Square miles
USGS = U.S. Geological Survey
AU = Assessment Unit

4Q3 derivations for ungaged streams were based on analysis methods described by Waltemeyer (2002). Two regression equations for estimating 4Q3 were developed based on physiographic regions of New Mexico (i.e., statewide and mountainous regions above 7,500 feet in elevation). The following regression equation for mountainous regions above 7,500 feet in elevation is based on data from 40 gaging stations with non-zero discharge (Waltemeyer 2002):

$$4Q3 \quad = \quad 7.3287 \times 10^{-5} \; DA^{0.70} \; P_w^{\;3.58} \; S^{1.35}$$

where,

4Q3 = Four-day, three-year low-flow frequency (cfs)
DA = Drainage area (mi^2)
P_w = Average basin mean winter precipitation (inches)
S = Average basin slope (percent)

The average SEE and coefficient of determination are 94 and 66 percent, respectively, for this regression equation (Waltemeyer 2002). The drainage areas, average basin mean winter precipitation, and average basin slope for assessment units where this regression method was used are presented in the following table:

Table C.3 Parameters for Estimating Flow using USGS Regression Model

Assessment Unit	Regression Model	Average Elevation for Assessment Unit (feet)	Mean Basin Winter Precipitation (inches)	Average Basin Slope (unitless)
NM-2120.A_835	(a)	10,144	11.44	28.4
NM-2120.A_837	(a)	10,003	12.47	25.7
NM-2120.A_839	(a)	9,577	11.52	17.8
NM-2306.A_162	(a)	8,448	8.83	16.5

Notes:
mi^2 = Square miles
n/a = not applicable
[a] Waltemeyer (2002) mountainous

Based on the methods described above, the following values were estimated for inflow:

Table C.4 Inflow

Assessment Unit	Ref.	4Q3 (cfs)	DAt (mi^2)	DAg (mi^2)	Pw (in)	S unitless	Inflow (cfs)
NM-2120.A_835	(a)	–	0.2	–	11.44	28.4	0.00[1]
NM-2120.A_837	(a)	–	0.1	–	12.47	25.7	0.00[1]
NM-2120.A_839	(a)	–	0.1	–	11.52	17.8	0.00[1]
NM-2306.A_162	(a)	–	0.2	–	8.83	16.5	0.00[1]

Notes:
N/A = Not applicable, assessment unit begins at headwaters.
Ref. = Reference
[a] Waltemeyer (2002), mountainous
cfs = cubic feet per second
mi^2 = Square miles
in = Inches
Pw = Mean winter precipitation
DAt = Drainage area from top of segment
DAg = Drainage area from USGS gage
S = Average basin slope
[1] Inflow is zero because assessment unit begins at headwaters.

C2.2 Inflow Temperature

This parameter represents the *mean daily* water temperature at the top of the segment. 2006 data from thermographs positioned at the top of the assessment unit were used when possible. If the segment began at a true headwater, the temperature entered was zero degrees Celsius (^oC) (zero flow has zero heat). The following inflow temperatures for impaired assessment units were modeled in SSTEMP:

Table C.5 Mean Daily Water Temperature

Assessment Unit	Upstream Thermograph Location	Inflow Temp. (°C)	Inflow Temp. (°F)
NM-2120.A_835	None (headwaters)	0	32.0
NM-2120.A_837	None (headwaters)	0	32.0
NM-2120.A_839	None (headwaters)	0	32.0
NM-2306.A_162	None (headwaters)	0	32.0

Notes:
°C = Degrees Celsius
°F = Degrees Fahrenheit

C2.3 Segment Outflow

Flow data from USGS gages were used when available. To be conservative, the 4Q3 was used as the segment outflow. These critical low flows were used to provide a conservative estimate of the assimilative capacity of the stream to adsorb and disperse solar energy. Outflow was estimated using the methods described in Section C2.1. The following table summarizes 4Q3s used in the SSTEMP Model:

Table C.6 Segment Outflow

Assessment Unit	Ref.	4Q3 (cfs)	DAb (mi^2)	DAg (mi^2)	Pw (in)	S unitless	Outflow (cfs)
NM-2120.A_835	(a)	–	2.21	–	11.44	28.4	0.14
NM-2120.A_837	(a)	–	1.89	–	12.47	25.7	0.15
NM-2120.A_839	(a)	–	1.73	–	11.52	17.8	0.07
NM-2306.A_162	(a)	–	36.84	–	8.83	16.5	0.20

Notes:
Ref. = Reference
(a) Waltemeyer (2002), mountainous
(b) cfs = cubic feet per second
(c) mi^2 = Square miles DAb = Drainage area from bottom of segment
in = Inches DAg = Drainage area from USGS gage
Pw = Mean winter precipitation S = Average basin slope

C2.4 Accretion Temperature

The temperature of the lateral inflow, barring tributaries, generally should be the same as groundwater temperature. In turn, groundwater temperature may be approximated by the mean annual air temperature. Mean annual air temperatures for 2006 were used in the absence of measured annual data. The following table presents the mean annual air temperature for each assessment unit:

Table C.7 Mean Annual Air Temperature as an Estimate for Accretion Temperature

Assessment Unit	Ref.	Mean Annual Air Temperature (°C)	Mean Annual Air Temperature (°F)
NM-2120.A_835	(a)	6.55	43.783
NM-2120.A_837	(a)	6.55	43.783
NM-2120.A_839	(a)	6.55	43.783
NM-2306.A_162	(a)	6.55	43.783

Notes:
Ref. = References for Weather Station Data are as follows:
(a) *New Mexico State University Climate Network (Cimarron RAWS, Latitude 36.606100_N, Longitude 105.120300 W),* ***2006***
°F = Degrees Fahrenheit
°C = Degrees Celsius

C 3.0 GEOMETRY

C3.1 Latitude

Latitude refers to the position of the stream segment on the earth's surface. Latitude is generally determined in the field with a global positioning system (GPS) unit. Latitude for each assessment unit is summarized below:

Table C.8 Assessment Unit Latitude

Assessment Unit	Latitude (decimal degrees)
NM-2120.A_835	36.77
NM-2120.A_837	36.80
NM-2120.A_839	36.76
NM-2306.A_162	36.78

C3.2 Dam at Head of Segment

The following assessment units have a dam at the upstream end of the segment with a constant, or nearly constant diel release temperature:

Table C.9 Presence of Dam at Head of Segment

Assessment Unit	Dam?
NM-2120.A_835	No
NM-2120.A_837	No
NM-2120.A_839	No
NM-2306.A_162	No

C3.3 Segment Length

Segment length was determined with National Hydrographic Dataset Reach Indexing GIS tool. The segment lengths are as follows:

Table C.10 Segment Length

Assessment Unit	Length (miles)
NM-2120.A_835	2.87
NM-2120.A_837	2.86
NM-2120.A_839	2.57
NM-2306.A_162	7.03

C3.4 Upstream Elevation

The following upstream elevations were determined with National Hydrographic Dataset Reach Indexing GIS tool.

Table C.11 Upstream Elevations

Assessment Unit	Upstream Elevation (feet)
NM-2120.A_835	10,400
NM-2120.A_837	11,000
NM-2120.A_839	10,200
NM-2306.A_162	11,000

C3.5 Downstream Elevation

The following downstream elevations were determined with National Hydrographic Dataset Reach Indexing GIS tool.

Table C.12 Downstream Elevations

Assessment Unit	Downstream Elevation (feet)
NM-2120.A_835	9,200
NM-2120.A_837	9,250
NM-2120.A_839	9,240
NM-2306.A_162	7,840

C3.6 Width's A and Width's B Term

Width's B Term was calculated as the slope of the regression of the natural log of width and the natural log of flow. Width-versus-flow regression analyses were prepared by entering cross-section field data into a Windows-Based Stream Channel Cross-Section Analysis (WINXSPRO 3.0) Program (U.S. Department of Agriculture [USDA] 2005). Theoretically, the Width's A Term is the untransformed Y-intercept. However, because the width versus discharge relationship tends to break down at very low flows, the Width's B-Term was first calculated as the slope and Width's A-Term was estimated by solving for the following equation:

$$W = A \times Q^B$$

where,

W = Known width (feet)
A = Width's A-Term (seconds per square foot)
Q = Known discharge (cfs)
B = Width's B-Term (unitless)

The following table summarizes Width's A- and B-Terms for assessment units requiring temperature TMDLs:

Table C.13 Width's A and Width's B Terms

Assessment Unit	Width's B-Term	Width's A-Term
NM-2120.A_835	0.528	0.641
NM-2120.A_837	0.102	6.78
NM-2120.A_839	0.528 [a]	0.641 [a]
NM-2306.A_162	1.61 [b]	0.008 [b]

[a] *geomorph data not available before public comment period, data from Gold Creek used as an estimate until data is available.*

[b] *geomorph data not available before public comment period, data from* 05McCrys002.0 *used as an estimate until data is available.*

The following figures present the detailed calculations for the Width's B-Term.

Measurements were collected at one site within these assessment units. The regression of natural log of width and natural log of flow for each location is as follows:

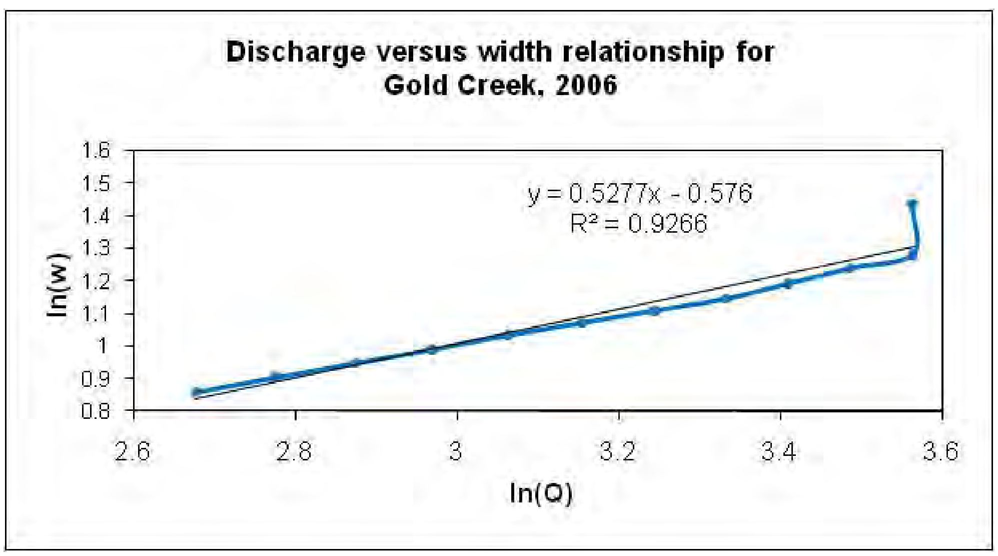

Figure C.1 Wetted Width versus Flow for Assessment Unit NM-2120.A_835

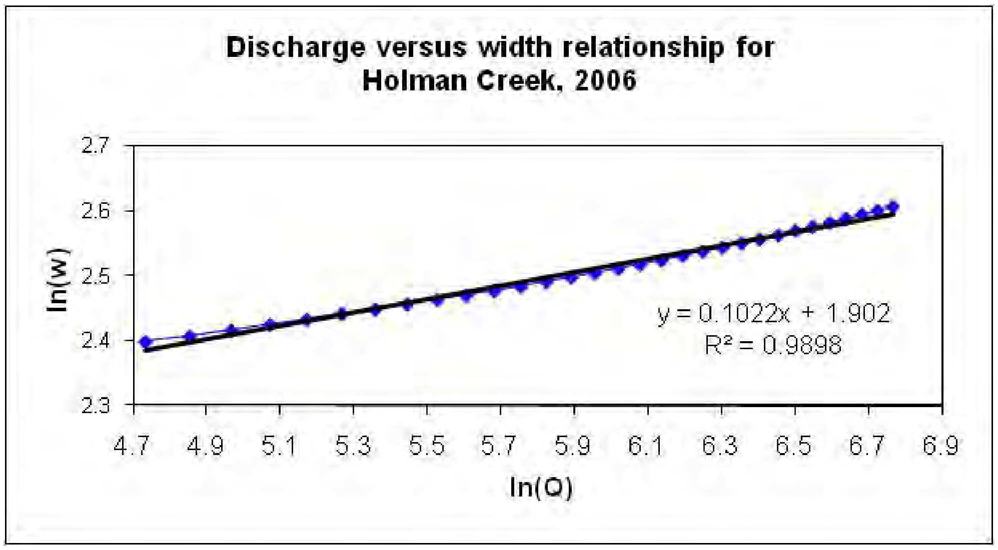

Figure C.2 Wetted Width versus Flow for Assessment Unit NM-2120.A_837

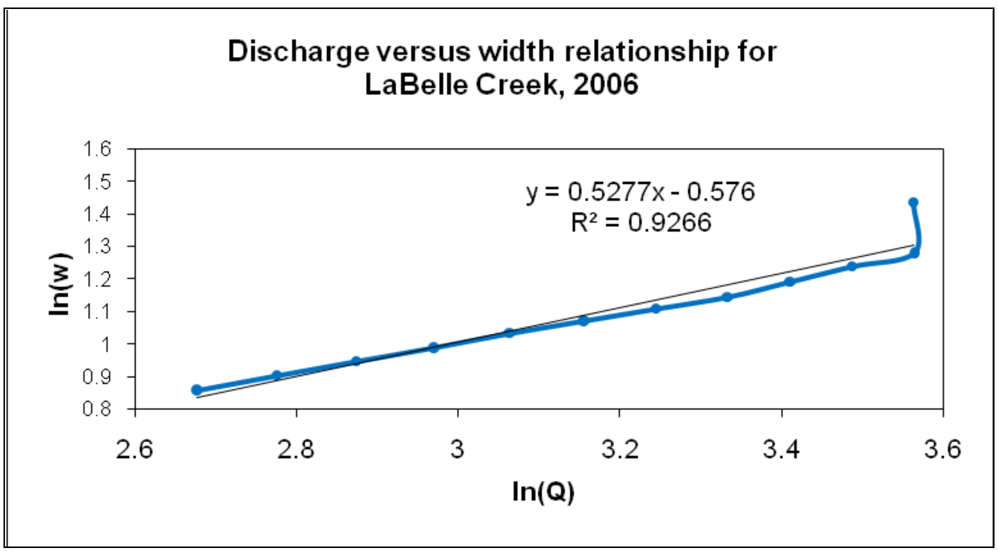

Figure C.3 Wetted Width versus Flow for Assessment Unit NM-2120.A_839

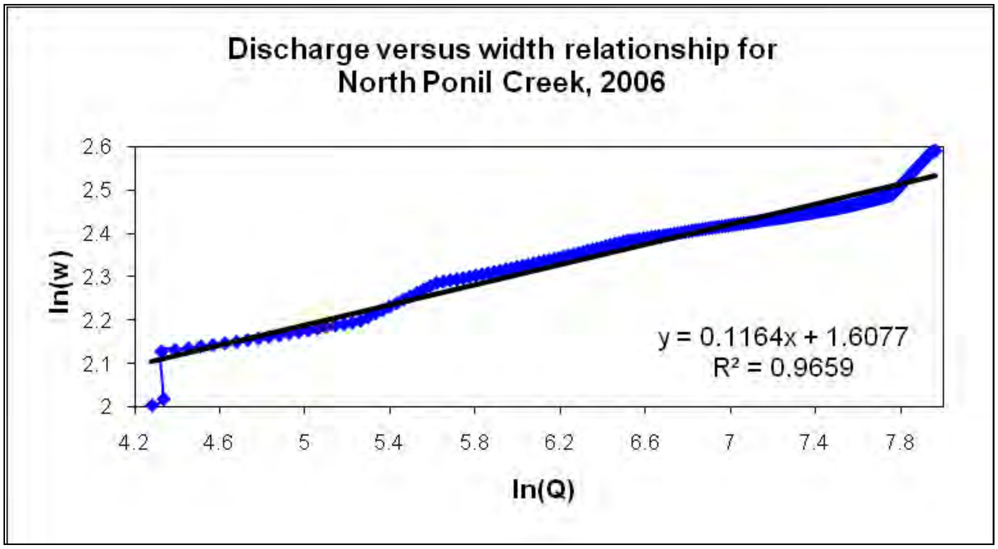

Figure C.4 Wetted Width versus Flow for Assessment Unit NM-2306.A_162

C3.7 Manning's n or Travel Time

Site-specific values were calculated using Strickler's equation to estimate Manning's roughness based on prevailing sediment sizes in the streambed:

$$n = \frac{(d_{50})^{1/6}}{21.0}$$

where d_{50} is the median sediment size in meters.

The following table summarizes the Manning's n input values for each assessment unit:

Table C.14 Manning's n values

Assessment Unit	d_{50} (in meters)	Manning's n
NM-2120.A_835	0.0185	0.025
NM-2120.A_837	0.0095	0.022
NM-2120.A_839	0.0185*	0.025*
NM-2306.A_162	0.0095	0.022

* *geomorph data not available before public comment period, data from Gold Creek used as an estimate until data is available.*

C 4.0 METEOROLOGICAL PARAMETERS

C4.1 Air Temperature

This parameter is the mean daily air temperature for the assessment unit (or average daily temperature at the mean elevation of the assessment unit). Air temperature will usually be the single most important factor in determining mean daily water temperature. Air temperatures are usually measured directly (in the shade) using air thermographs and adjusted to what the temperature would be at the mean elevation of the assessment unit. The following table summarizes mean daily air temperatures for each assessment unit (for its modeled date) as recorded by SWQB air thermographs in 2006. July average air temperatures from the Prism data set are also presented. This data set contains spatially gridded average monthly temperature for the climatological period 1971-2000 for any specific site. http://www.prism.oregonstate.edu/

Table C.15 Mean Daily Air Temperature

Assessment Unit	Elevation at Air Thermograph Location (meters)	Mean Elevation for Assessment Unit (meters)	Measured Mean Daily Air Temperature (°C)	Prism data- July Average Air Temperature (°C)	Adjusted Mean Daily Air Temperature (°F)
NM-2120.A_835	2804 [a]	3092	14.1	13.2	55.76
NM-2120.A_837	2804 [a]	3049	14.1	13.2	55.76
NM-2120.A_839	2804 [a]	2919	14.1	13.2	55.76
NM-2306.A_162	2394 [b]	2575	17.2	16.3	61.34

Notes:

°F = Degrees Fahrenheit
°C = Degrees Celsius
[a] *Air thermograph at 28Gold000.1*
[b] *Air thermograph at 05Seally000.2*

C4.2 Maximum Air Temperature

Unlike the other variables, the maximum daily air temperature overrides only if the check box is checked. If the box is not checked, the SSTEMP Model estimates the maximum daily air temperature from a set of empirical coefficients (Theurer et al., 1984 as cited in Bartholow 2002) and will print the result in the grayed data entry box. A value cannot be entered unless the box is checked.

C4.3 Relative Humidity

Relative humidity data were obtained from the New Mexico State University Climate Network (http://weather.nmsu.edu/data/data.htm). The data were corrected for elevation and temperature using the following equation:

$$R_h = R_o \times \left(1.0640^{(To-Ta)}\right) \times \left(\frac{T_a + 273.16}{T_o + 273.16}\right)$$

where,

R_h = relative humidity for temperature T_a (decimal)
R_o = relative humidity at station (decimal)
T_a = air temperature at segment (°C)
T_o = air temperature at station (°C)

The following table presents the adjusted mean daily relative humidity for each assessment unit:

Table C.16 Mean Daily Relative Humidity

Assessment Unit	Mean Daily Air Temp. at Weather Station (°C)	Mean Daily Air Temperature at AU (°C)[1]	Mean Daily Relative Humidity at Weather Station (percent)[2]	Mean Daily Relative Humidity for AU (percent)
NM-2120.A_835	15.23	13.2	50.54	53.50
NM-2120.A_837	16.20	13.2	73.17	68.07
NM-2120.A_839	13.33	13.2	36.00	64.61
NM-2306.A_162	19.98	16.3	34.00	51.34

Notes:
[1] From Table C.15
[2] *New Mexico State University Climate Network (Cimarron RAWS, Latitude 36.606100 N, Longitude 105.120300 W),* ***modeled dates in 2006***
AU = Assessment Unit
°C = Degrees Celsius

C4.4 Wind Speed

Average daily wind speed data were obtained from the New Mexico State University Climate Network (http://weather.nmsu.edu/data/data.htm). The following table presents the mean daily wind speed for each assessment unit:

Table C.17 Mean Daily Wind Speed

Assessment Unit	Mean Daily Wind Speed (miles per hour)[1]	Date
NM-2120.A_835	3.708	6/23/2006
NM-2120.A_837	4.292	7/26/2006
NM-2120.A_839	4.000	6/3/2006
NM-2306.A_162	4.273	7/16/2006

Notes:
[1] *New Mexico State University Climate Network (Cimarron RAWS, Latitude 36.606100_N, Longitude 105.120300 W)*

C4.5 Ground Temperature

Mean annual air temperature data for 2006 were used in the absence of measured data. The following table presents the mean annual air temperature for each assessment unit:

Table C.18 Mean Annual Air Temperature as an Estimate for Ground Temperature

Assessment Unit	Ref.	Mean Annual Air Temperature (°C)	Mean Annual Air Temperature (°F)
NM-2120.A_835	(a)	6.55	43.783
NM-2120.A_837	(a)	6.55	43.783
NM-2120.A_839	(a)	6.55	43.783
NM-2306.A_162	(a)	6.55	43.783

Notes:
Ref. = References for Weather Station Data are as follows:
(a) *New Mexico State University Climate Network (Cimarron RAWS, Latitude 36.606100_N, Longitude 105.120300 W),* ***2006***
ºF = Degrees Fahrenheit ºC = Degrees Celsius

C4.6 Thermal Gradient

The default value of 1.65 was used in the absence of measured data.

C4.7 Possible Sun

Percent possible sun for Albuquerque is found at the Western Regional Climate Center web site http://www.wrcc.dri.edu/htmlfiles/westcomp.sun.html#NEW%20MEXICO. The percent possible sun is 83 for June and 76 for July for the Albuquerque station.

C4.8 Dust Coefficient

If a value is entered for solar radiation, SSTEMP Model will ignore the dust coefficient and ground reflectivity and "override' the internal calculation of solar radiation. Solar radiation data are available from the New Mexico State University Climate Network (see Section 4.10).

C4.9 Ground Reflectivity

If a value is entered for solar radiation, SSTEMP Model will ignore the dust coefficient and ground reflectivity and "override' the internal calculation of solar radiation. Solar radiation data are available from the New Mexico State University Climate Network (see Section 4.10).

C4.10 Solar Radiation

Because solar radiation data were obtained from an external source of ground level radiation, it was assumed that about 90% of the ground-level solar radiation actually enters the water. Thus, the recorded solar measurements were multiplied by 0.90 to get the number to be entered into the SSTEMP Model.

Table C.19 Mean Daily Solar Radiation

Assessment Unit	Date	Mean Solar Radiation (L/day) [1]	Mean Solar Radiation x 0.90 (L/day)
NM-2120.A_835	6/23/2006	558.98	503.09
NM-2120.A_837	7/26/2006	461.64	415.48*
NM-2120.A_839	6/3/2006**	456.26	410.64
NM-2306.A_162	7/16/2006	667.32	600.59

[1] *New Mexico State University Climate Network (Cimarron RAWS, Latitude 36.606100 N, Longitude 105.120300 W)*

* mean daily solar radiation for the month of July 2006 was used.

** no data available for 6/3/2006, data for 6/4/2006 was used

C 5.0 SHADE

Percent shade was estimated for the assessment units using field estimations per geomorphological survey field notes from 2006. The value in Table C.20 reflects the average of 6 measurements at each of 2 or 3 cross-sections in 2006. The measurements may have also been averaged along with visual estimates using USGS digital orthophoto quarter quadrangles downloaded from New Mexico Resource Geographic Information System Program (RGIS), online at http://rgis.unm.edu/. This parameter refers to how much of the segment is shaded by vegetation, cliffs, etc. The following table summarizes percent shade for each assessment unit:

Table C.20 Percent Shade

Assessment Unit	Site	Date	Percent Shade
NM-2120.A_835	28Gold000.1	5/23/2006	0%
NM-2120.A_837	28Holman000.1	5/23/2006	17%
NM-2120.A_839	28LaBell000.1*	5/23/2006*	9%*
NM-2306.A_162	05NPonil023.2	8/17/2006	12%

* *geomorph data not available before public comment period, data from Gold and Holman Creeks used as an estimate until data is available.*

D 6.0 REFERENCES

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APPENDIX D
PUBLIC PARTICIPATION FLOWCHART

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Monitoring, Assessment, & TMDL Development Process